National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Invasive Species Management in Katmai National Park & Preserve

2011 Summary Report

Natural Resource Data Series NPS/KATM/NRDS—2011/222

ON THE COVER
Left: Bird vetch (*Vicia cracca*). Upper Right: Fall dandelion (*Leontodon autumnalis*). Lower Right: The view from Fure's Cabin.
Photographs by: Peter Frank and Arielle Woods

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December 2011

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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This report is available from Alaska Region Exotic Plant Management Team Reports website (http://www.nps.gov/akso/NatRes/EPMT/reports.html) and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

Please cite this publication as:

Frank, P. and A. Woods. 2011. Invasive species management in Katmai National Park & Preserve: 2011 Summary report. Natural Resource Data Series NPS/KATM/NRDS—2011/222. National Park Service, Fort Collins, Colorado.

NPS 127/111969, December 2011

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Abstract

This year marks the second season that the Alaska Exotic Plant Management Team protocol for surveying and controlling invasive plants was followed throughout the growing season. A total of 13 non-native species have been documented in the park, with 10 more present in King Salmon. The majority of monitoring and manual control efforts occurred at Brooks Camp, Lake Camp, the Valley of Ten Thousand Smokes Road and at Fure's Cabin. Herbicide was applied for the first time in the park to control the common dandelion (*Taraxacum officinale* ssp. *officinale*) infestation at Fure's Cabin as well as bird vetch (*Vicia cracca*) along the Valley of Ten Thousand Smokes Road. Continued treatment at heavily infested sites, such as the Brooks Camp cultural site, has significantly reduced the extent and density of infestations in these areas. Expanding the areas surveyed within the park was a high priority this season, thus inventories were conducted in the Katmai National Preserve at Funnel and Moraine Creeks and Crosswind Lake, Geographic Harbor, Takli and Little Takli Islands, in the Bay of Islands and at Idavain and Margot Creeks. New species documented in 2011 include: common mouse-ear chickweed (*Cerastium fontanum*), common chickweed (*Stellaria media*) and European forget-me-not (*Myosotis scorpioides*) in the park and narrowleaf hawkweed (*Hieracium umbellatum*) and Iceland poppy (*Papaver nudicaule*) in King Salmon. New infestations were discovered at Moraine Creek, Idavain Creek, Fure's Cabin and lodges in Kukak and Kaguyak Bays. Invasive plant infestations in Katmai are relatively narrow in extent and severity due in part to the park's remote location; therefore, continued monitoring and control can reduce infestations and prevent their spread beyond areas of high disturbance. Finally, ongoing and planned construction and relocation projects at Brooks Camp will disturb existing vegetation, exposing new areas to colonization by non-native plants. Development of revegetation plans will help to minimize disturbance and restore the landscape post-construction.

Acknowledgments

We would like to thank the following National Park Service employees for their assistance to the Katmai Exotic Plant Management Team this season: Interpretative Rangers Imes Vaughn & Barbie Brooking for their assistance in treating invasive species at Brooks Camp, Mike Fitz for monitoring and reporting infestations he observed in the park, Red Clanton for his logistical assistance with the Brooks Camp Utility Project, and finally Bonnie Million and Tim Federal for their efforts applying herbicide for the first time in Katmai as well as their continued efforts in compiling and managing the EPMT data.

Abbreviations

AKNHP	Alaska Natural Heritage Program
ANIA	Aniakchak National Monument & Preserve
BCDA	Brooks Camp Developed Area
EPMT	Exotic Plant Management Team
FAA	Federal Aviation Administration
GPS	Global Positioning System
KATM	Katmai National Park & Preserve
NPS	National Park Service
SAGA	Southeast Alaska Guidance Association
SAVEC	Southwest Alaska Vocational & Education Center
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
VTTS	Valley of Ten Thousand Smokes

Introduction

Background

Katmai National Park and Preserve (KATM) lies at the head of the Alaskan Peninsula and covers 4.1 million acres of vast tundra fields, pristine waters and mountainous valleys, all accessible only by boat or plane (Figure 1). Much of the landscape is untouched except by natural successional forces, but the wildlife and scenery draw thousands of visitors annually, posing a threat to Katmai's ecological integrity. Of particular concern are the effects of exotic species on the native vegetation. The introduction of invasive plants is impeded by the park's remote location, which limits anthropogenic disturbance and transport of plant material, as well as its circumboreal climate, which is intolerable to many non-native plants. Despite logistic and climatic hindrances, the park remains vulnerable to the establishment and spread of invasive plants. Brooks Camp and Lake Camp are the developed sites that receive the highest influx of visitors, and thus contain the most extensive infestations in the park, while smaller infestations have escaped to some backcountry sites.

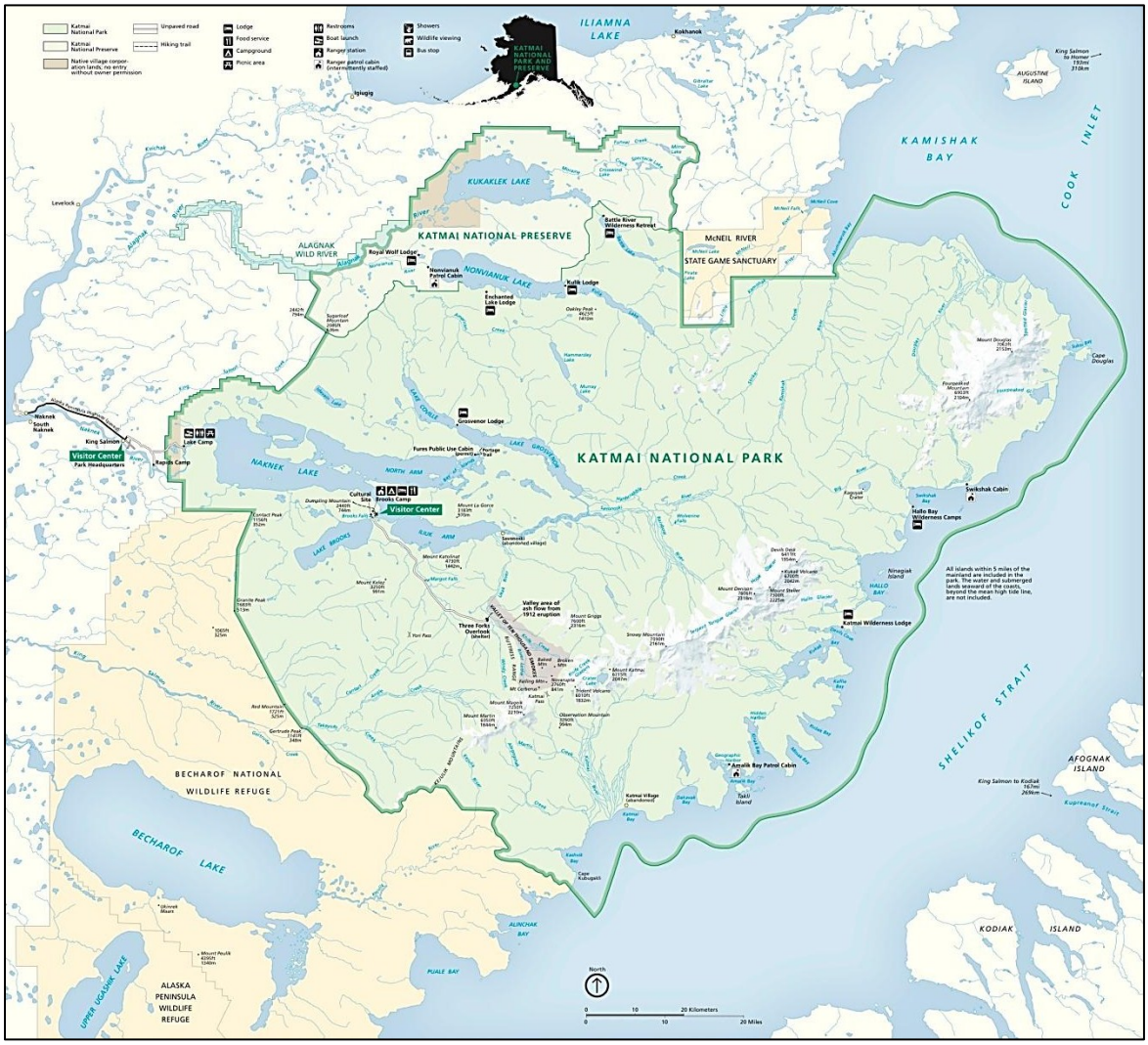

Figure 1. A map of the Katmai National Park & Preserve.

Invasive plants threaten native ecosystems because they have evolved in a separate environment and are adapted to a distinct set of resources, so the competitive influences that normally limit their spread do not exist when they invade a new ecosystem. Their ability to outcompete native plants can reduce local biodiversity and contribute to habitat degradation and alteration of essential ecosystem functions, as well as compromise the genetic integrity of native plants through hybridization (Vitousek et al. 1997, D'Antonio et al. 2001). Furthermore, models for milder temperatures and increased precipitation in Katmai, particularly in winters, associated with climate change have the potential to shift dispersal patterns of non-native plants and facilitate their colonization of northern latitudes (Rupp and Loya 2009, Walther 2000).

Invasive plant survey and management history

Global Positioning System (GPS) data showing the extent of invasive plant infestations in Katmai were first collected by the US Geological Survey in 2000 and then by an Exotic Plant Management Team (EPMT) crew member in 2005 for synthesis into two regional databases: Alien Plant Control and Monitoring, a nationwide National Park Service (NPS) database for invasive plant data, and the Alaska Exotic Plants Information Clearinghouse, a web-based database and mapping application providing geospatial information for non-native plants in Alaska and the Yukon run by the Alaska Natural Heritage Program (AKNHP) (Rapp 2008). Thorough surveys in 2005 were conducted at Lake Camp, Brooks Camp, the Valley of Ten Thousand Smokes road, and along the outer coast at Hallo, Swikshak and Kaguyak Bays. Small infestations and high priority species were manually treated (Bauder and Heys 2005). Control work by a single volunteer occurred in 2006 and 2007 at Brooks Camp, joined in 2007 by a Tribal Civilian Corps crew, focusing on common dandelion at Brooks Camp (Rapp 2008). Southeast Alaska Guidance Association (SAGA) AmeriCorps crews performed control work from 2008 through the present at Brooks Camp and Lake Camp (M. Fitz, personal communication, September 2, 2011). 2010 was the first season that Katmai had staffing throughout the summer focused on invasive plant work., with a focus on Brooks Camp, the Valley of Ten Thousand Smokes (VTTS) Road, Lake Camp and King Salmon. Infestations at Fure's Cabin and Nonvianuk ranger cabin were also controlled, and Jojo Lake was surveyed with nothing found.

The objective of the 2011 KATM EPMT was to monitor and control infestations in the park while creating unique strategies for prevention and restoration. During the 2011 field season, all sites at Brooks Camp, the VTTS road, Lake Camp and Fure's Cabin were revisited and infestations were treated manually, and herbicides were applied to common dandelion at Fure's Cabin and bird vetch along the VTTS road. Multiple small, disjunct infestations of common invasive species were discovered in previously un-infested spots at Brooks Camp and treated upon each encounter. Newly inventoried sites this year included the Bay of Islands, Margot Creek, Idavain Creek, Hallo Bay, Geographic Harbor and the Katmai National Preserve. Some of the tactics used to prevent further spread of invasive species into the park included informational signs, boot brushes and vehicle inspections. The 2011 KATM EPMT developed a re-vegetation manual to be used in future project planning to minimize species introductions and effectively restore disturbed areas before they are colonized by invasive species. Accurate GPS data, along with early detection and rapid response tactics, provide Katmai the opportunity to strategically control current infestations and prevent their spread into backcountry locations, before invasive plants become a more severe ecological threat.

Methods

Fieldwork in KATM was conducted from May to September 2011 in accordance with the 2011 Alaska EPMT Field Protocol (Million and Rapp 2011). The majority of field work was conducted by Student Conservation Association interns Peter Frank and Arielle Woods and KATM EPMT coordinator Whitney Rapp. An eight person SAGA AmeriCorps youth crew contributed their efforts for 10 days in early June at Brooks Camp, Fure's Cabin and Lake Camp, providing 640 volunteer hours.

Fieldwork consisted of surveying for and inventorying invasive species within the park, and when feasible and strategic, infestations were controlled manually or chemically. All areas inventoried or treated were mapped using a Trimble GeoExplorer 2008 Series GeoXT or GeoXH GPS unit equipped with a standardized Alaska EPMT data dictionary specific to KATM. Manual treatment via hand pulling or digging was centered around highly trafficked areas in the park such as Brooks Camp, Lake Camp and Fure's Cabin, with specific focus on eradicating small infestations and containing larger ones. Previously identified infestations which met criteria detailed in the Alaska Region Invasive Plant Management Plan (2010) were also chemically treated in 2011. Herbicide treatments using the broad-leaf specific herbicide Milestone VM, with the active ingredient of aminopyralid, was applied with the assistance of regional Alaska EPMT staff to control common dandelion (*Taraxacum officinale* ssp. *officinale*) at Fure's Cabin and bird vetch (*Vicia cracca*) along the VTTS Road.

Control and monitoring efforts were focused primarily on the most heavily visited and infested areas within the park. The Brooks Camp Developed Area (BCDA), which has the highest visitation and most severe infestations, was visited monthly throughout the season. Lake Camp, a peripherally-located access point from King Salmon into the park, also received a steady input of manual treatment efforts. A major priority this season was expanding upon the areas surveyed within the park; therefore, surveys were conducted for the first time in the following areas: Katmai National Preserve at Funnel and Moraine Creeks and Crosswind Lake, Geographic Harbor, Takli and Little Takli Islands, Hallo Bay, the Bay of Islands, near Hallo Bay Bear Camps, near Katmai Wilderness Lodge, and at Idavain and Margot Creeks

Results

Overview

During the 2011 season, KATM EPMT staff surveyed over 39 species acres for invasive plants. 10.123 species acres were infested with invasive plants. Of those 10.123 acres, 3.793 species acres were treated. The season's efforts are summarized in Table 1 below. Table 2 summarizes specific species observations in different locals, emphasizing those species which are not yet within the management boundary of KATM. Site specific maps of the main infestations of concern described in this section can be found in Appendix A.

Table 1. Annual summary of Katmai National Park & Preserve Exotic Plant Management.

Year	EPMT Personnel		Volunteers		Total Person Field Hours	Invasive GPS Data NPS Lands(non-NPS lands)			New Spp.
	# pers.	Field Hours	# pers.	Field hours		Species Acres Surveyed	Species Acres Infested*	Acres Treated	
2005	2	91	-	-	91	174.325 (37.507)	6.622 (0.012)	0.076	9
2007	1	35	6	192	227	5.198	0.526	0.495	-
2008	1	64	8	240	304	6.112	0.495	0.495	-
2009	1	27	8	56	83	3.071	0.631	0.083	1
2010	2	694	8	640	1,334	105.959 (14.527)	14.417 (0.292)	7.464 (0.276)	3
2011	2	xxx	8	640	xxx	37.562 (1.497)	8.626 (1.497)	3.650 (0.143)	3

* Acres infested are calculated by acres mapped times the percent cover in areas greater than 0.5 acres. If under 0.5 acres, acreage mapped is counted as 100%.

2011 Season Highlights

- Significant reduction in common dandelion abundance near the Brooks Camp cultural site.
- A misidentification of non-native prostrate knotweed (*Polygonum aviculare*) was positively identified as the native Fowler's knotweed (*Polygonum fowleri*) at Brooks Camp.
- Herbicide was used for the first time this season to treat common dandelion at Fure's Cabin and bird vetch along the VTTS Road.
- Two new species, common mouse-ear chickweed (*Cerastium fontanum*) and common chickweed (*Stellaria media*) were discovered in the park this year. One new species, narrowleaf hawkweed (*Hieracium umbellatum*), was discovered in King Salmon.
- Developed and presented an educational campaign for Alaska Invasive Weeds Awareness week, which included hanging signs in local establishments and giving informative lessons to children at the King Salmon visitor center.
- Installation of boot brushes and informative signs at the NPS float plane dock, Lake Camp, Brooks Camp visitor center and Three Forks visitor center to raise awareness and prevent the spread of invasive plants.
- Developed a restoration and revegetation manual for Katmai to be referenced in planning for future construction projects.

Table 2. Invasive plant species observed by the KATM EPMT in Katmai National Park & Preserve and King Salmon.

Species		Inv rank*	Within KATM						King Salmon, AK							
Latin Name	Common Name		BC DA	VTTS Road	Lake Camp	Fure's Cabin	Outer coast	Other site	NPS Office	NPS Maint Yard	NPS Housing	FAA Housing	Air Force Base	US FWS	King Ko Inn	Other site
Capsella bursa-pastoris	shepherd's purse	40	X	X	X	X	-	-	X	X	X	X	-	-	-	-
Cerastium fontanum	mouse ear chickweed	36	-	X	-	X	X	X	-	-	-	-	-	-	-	-
Crepis tectorum	narrowleaf hawksbeard	56	-	X	-	-	-	-	X	X	-	X	-	-	-	X
Leontodon autumnalis	fall dandelion	51	-	-	X	-	-	-	-	-	-	X	-	-	-	X
Matricaria discoidea	pineapple weed	32	X	X	X	X	X	X	X	X	X	X	-	X	X	-
Myosotis scorpioides	European forget-me-not	54	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Plantago major	common plantain	44	X	-	-	-	X	X	-	O	-	X	-	-	-	-
Poa annua	annual bluegrass	46	X	-	-	X	X	X	-	-	-	-	-	-	-	-
Rumex acetosella	common sheep sorrel	51	O	-	X	-	-	-	-	-	X	X	-	O	-	-
Stellaria media	common chickweed	42	-	-	-	-	X	-	-	-	-	-	-	-	-	-
Taraxacum officinale ssp. *officinale*	common dandelion	58	X	-	X	X	-	-	X	-	X	X	X	X	X	X
Trifolium repens	white clover	59	O	-	-	-	-	-	-	-	X	-	-	-	X	-
Vicia cracca	bird vetch	73	-	X	-	-	-	-	-	-	-	-	-	-	-	X
Bromus inermis ssp. *inermis*	smooth brome	62	-	-	-	-	-	-	-	-	-	X	-	-	-	X
Caragana arborescens	Siberian peashrub	74	-	-	-	-	-	-	-	-	-	-	X	-	-	X
Galeopsis bifida	split-lip hempnettle	50	-	-	-	-	-	-	-	-	-	-	-	-	-	O
Hieracium umbellatum	narrowleaf hawkweed	51	-	-	-	-	-	-	-	-	-	-	X	-	-	X
Leucanthemum vulgare	oxeye daisy	61	-	-	-	-	-	-	X	-	X	X	-	-	X	O
Papaver nudicaule	Iceland poppy	39	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Prunus padus	European bird cherry	74	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Sorbus aucuparia	European mountain ash	59	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Tanacetum vulgare	common tansy	60	-	-	-	-	-	-	-	-	-	O	-	-	-	O
Trifolium hybridum	alsike clover	57	-	-	-	-	-	-	X	-	X	X	-	-	X	-
Tripleurospermum inodurum	scentless false mayweed	48	-	-	-	-	-	-	X	-	-	-	-	-	-	-

X- Observed during 2011 EPMT field season.
O- Observed during prior EPMT field seasons but not in 2011.
* (AKNHP 2011)

Brooks Camp

Brooks Camp is situated at the mouth of Brooks River along the shore of Naknek Lake and is accessible via boat and plane (Figure 2). It attracts the highest concentration of domestic and international visitors to the park, and has become the most heavily infested area in the park. The BCDA contains NPS facilities and employee housing, as well as concessioner-operated Brooks Lodge and its associated visitor and employee lodging. Species commonly observed along trails, buildings and in mown areas include pineapple weed, shepherd's purse (*Capsella bursa-pastoris*), common dandelion, annual bluegrass (*Poa annua*) and common plantain. What was believed to be non-native prostrate knotweed was determined this year to be the native Fowler's knotweed, based upon the lustrous, smooth, olive brown achenes characteristic of the native species (Hultén 1968). Initial inventories of the BCDA were conducted in May before the arrival of an eight-person SAGA AmeriCorps youth crew in June. The SAGA crew contributed significant control person hours at Brooks Camp, and infestations were retreated throughout the season by KATM EPMT staff.

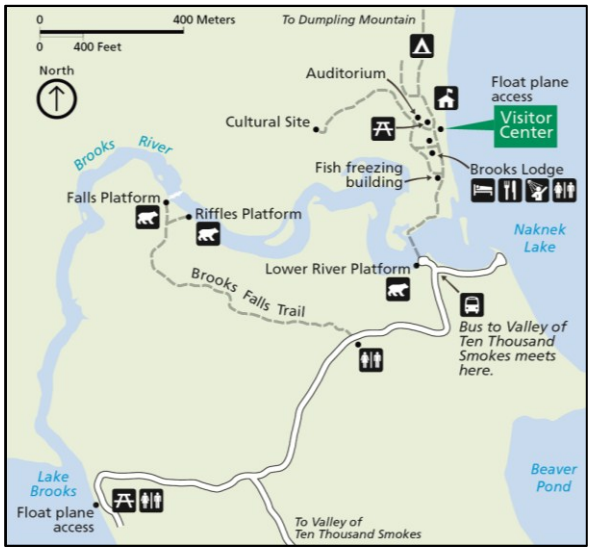

Figure 2. The Brooks Camp Developed Area.

Campground and Dumpling Mountain

The Brooks Camp campground is the only improved camping area in KATM, and experiences a high rate of visitor turnover throughout the summer. There is a high level of disturbance along the footpaths, in cleared areas and near permanent storage facilities. The infestations are more advanced in the north half of the campground, and include common dandelion, common plantain, pineapple weed and shepherd's purse.

In June 96-100% of common dandelions were treated with SAGA, mostly concentrated at the far northwest corner and along the electric perimeter fence, and in a large central campsite, with smaller infestations in other campsites and along some footpaths. All common dandelions were retreated in July and August, the perimeter was surveyed and escaping individuals of common plantain and dandelion were removed. The south side of the campground was inventoried in full and found to be mostly free of invasive plants except for a few individuals of plantain. Large infestations of plantain, shepherd's purse and pineapple weed were inventoried throughout campsites and trails on the entire north side, so July and August efforts focused on containing smaller outlier infestations. Two campsites, one located in the northwest corner and one centrally located in the north half, have especially dense infestations of plantain that is spreading along footpaths. Due to plantain's late phenology, adequate control efforts would require either a late-season SAGA crew or a significant contribution of control person hours by KATM EPMT staff in August and September. The phenology of all invasive plants in the campground is delayed due to dense shade and control is further complicated during June and July due to the large number of occupied campsites, so control efforts are more effective later in the season.

The trail leading to the campground is heavily shaded and largely free of invasive plants except for patches of annual bluegrass. In July, only one common dandelion and five pineapple weed individuals were discovered on the trail near the campground gate, and continued vigilance will ensure that invasive plants do not take hold on the trail. North of the campground is Dumpling Mountain, a popular hiking spot whose trailhead begins at the campground fence. Small patches of plantain reported in 2010 were revisited approximately 0.4 km up the trail but were not detected in June or July surveys. This could indicate that these infestations responded well to manual treatment, although they could emerge later in the season. In July 2011 a patch of plantain was discovered on the trail just below the first overlook, which is the furthest extent of plantain on Dumpling Mountain. All individuals were removed and the site should be revisited multiple times next season.

Employee Facilities

Most employee facilities in the BCDA are situated between the ranger station and the campground. Pineapple weed is sporadically dispersed along trail edges and in front of the bathhouse, incinerator, maintenance shop, gear caches, leach field and generators. Pineapple weed and annual bluegrass grow on the edges of "Park Avenue," the gravel trail along which seasonal cabins and tent frames are located. These infestations have not spread into the native vegetation surrounding footpaths or the perimeters of employee housing structures. Informal control of pineapple weed has been carried out throughout the area by seasonal bear technician Imes Vaugn. The SAGA crew helped control a moderate infestation of plantain in front of the generators and diesel tanks, which was fully retreated in July and August with less effort required. A few individuals of plantain that had escaped along Park Avenue were removed as well. A total of 15 common plantains were removed from behind the incinerator building, as well as common dandelion along the building's south side. In July shepherd's purse was treated at the generator trail and the trail between the visitor center and ranger station, as well as small infestations at the leach field and beside the maintenance shop. The immediate vicinity of the yurt is free of invasive plants besides the removal of two dandelions. Tuckerville houses Brooks Lodge employees and contains multiple invasive plants. Pineapple weed was inventoried at 1-5% cover throughout its entirety, and all dandelion and shepherd's purse infestations were removed around cabins, as well as 3 plantains near the entrance gate.

Cultural Site

Three dandelions were found and removed near the auditorium ramp, which lies at the head of the trail leading to the cultural site. Annual bluegrass grows along the length of the trail, and small infestations of pineapple weed and shepherd's purse are present sporadically, increasing in density closer to the cultural site. The Brooks Camp cultural site exhibit is a reconstructed prehistoric house located a short walk from the visitor center. The south-facing lawn is maintained with occasional brush cutting and has a significant infestation of common dandelion, which has been decreasing in density through repeated manual treatments in recent years. 96-100% of dandelions were removed from the lawns and trail in June with the assistance of SAGA, including all dandelions escaping into the surrounding grassy slopes, and 51-75% of pineapple weed. Dandelions were retreated in July and August with less effort, and an infestation of shepherd's purse directly in front of the door was also removed. August control efforts removed an estimated 76-95% of dandelions from the lawns, due to a combination of high vegetation and attempts to avoid excessive trampling of native plants. Limited numbers of shepherd's purse

scattered throughout the lawn were visible for the first time in August and removed, as were isolated patches of pineapple weed and shepherd's purse on the trail.

Due to the presence of an extensive non-native seed bank and substantial devegetation from removal efforts, the cultural site lawn was reseeded with native yarrow (*Achillea millefolium*) and large-leafed avens (*Geum macrophyllum*) in September of 2010, and large-leafed avens and tall Jacob's ladder (*Polemonium acutiflorum*) in August of 2011. Manual control and revegetation efforts have made considerable reductions in the size and density of the dandelion infestation (Figure 3), and the site should be retreated multiple times each season to prevent a strong reemergence and to ensure the success of native plants.

Figure 3. Repeated manual treatments and reseeding efforts at the Brooks Camp cultural site have shifted the plant composition from primarily common dandelion (left) to mostly native species (right).

Brooks Lodge

The majority of control work conducted at Brooks Lodge facilities was focused on common dandelion, which is present in the mown lawns and path edges of the lodge, Katmai Trading Post, fish freezing building and visitor cabins. Infestations increase slightly in density approaching the Skytel building but rarely exceed 1-5% cover. 96-100% of dandelions were removed from these locations in June with the help of the SAGA crew, they were retreated in July and August with decreasing effort, and the majority of dandelions were not allowed to go to seed. Shepherd's purse closely resembles a native mustard, lyrate rock cress (*Arabis lyrata*), and due to later phenology the two could not be distinguished until stem leaves or seed pods were present in July or later in most locations. Small infestations of shepherd's purse were removed from the fish freezing building and the gravel inlet directly south of it, the trading post lawn, and underneath the steps of the trading post and lodge scale in July and August. Shepherd's purse is interspersed with native mustards underneath the visitor cabins and lodge bath house, and they could not be distinguished from each other until August; care must be taken to selectively remove only non-native plants in these locations. Some cabins were treated in August and the rest were inventoried due to time constraints. Pineapple weed and annual bluegrass grow along the edges of most paths in this area, as well as along the beach in front of the fish freezing building. Throughout the season in the BCDA, small and isolated infestations of pineapple weed and shepherd's purse were treated opportunistically upon encounter, but their invasiveness ranking makes them a lower priority species. A patch of white clover (*Trifolium repens*) in front

of the Brooks Lodge bathhouse discovered in 2005 was treated over multiple years and could not be relocated in 2010 or 2011, indicating that it has likely been eradicated from the park.

Mouth of Brooks River

The mouth of Brooks River receives constant traffic from anglers, pedestrians, small vehicles, boats and bears, and displays multiple infestations that are considerably advanced in some locations. On the north side of the river, a wide gravel trail leads from Brooks Lodge facilities to "the corner," a graveled clearing at the bridge entrance. The trail contains pineapple weed and shepherd's purse along its edges, increasing in density towards the river bank. Directly east of the corner is "the point," the furthest extent of the beach and a common fishing spot. The bear trails leading to the point are infested with pineapple weed, and the bank between the corner and point has a small patch of shepherd's purse which was treated upon each visit. Isolated infestations of shepherd's purse along the beach in front of the fish freezing building were also treated to prevent their spread further down the beach. The island directly below the bridge also contains shepherd's purse, but this infestation will remain isolated.

The closed trail is a highly disturbed gravel bar upriver of the bridge that is regularly trampled by anglers. It was formerly a gravel trail leading to the bridge, but was abandoned in 2009 when the bridge was moved further downstream. Over the last three summers the closed trail has become inundated with pineapple weed, shepherd's purse and common dandelion to the point that little native vegetation grows in this area. In June the SAGA crew removed all scattered common dandelion and shepherd's purse from the closed trail (Figure 4). By July shepherd's purse infestations had expanded to occupy 1-5% and pineapple weed to 6-25% of the entire closed trail, and in August the majority of vegetation was comprised of non-native species, most notably a thick mat of pineapple weed. The effects of regular disturbance and an extensive seed bank are exacerbated by ample sunlight in this location, demonstrating how rapidly colonization by invasive species occurs under suitable conditions in the absence of restoration. Revegetation with native plants accompanied by measures to increase shading could combat the effects of ground disturbance and lead to reclamation of this site.

Figure 4. A SAGA crew removing shepherd's purse and common dandelion on the closed trail.

The lower platform is a permanent bear viewing structure situated on the south side of Brooks River. To the east of the platform is the gravel "spit road" leading to the barge landing area and beach. Pineapple weed was removed in June with SAGA from beneath the lower platform and along the banks near the bridge entrance, as well as from the barge landing zone and areas of the beach and spit road surrounding it. A small patch of shepherd's purse was removed midway down the spit road. By July and August, pineapple weed, and shepherd's purse especially, had greatly increased in density below the lower platform, on river banks and along the entire spit road, barge landing area, spit and beach. Due to the severity of the infestations only a few isolated patches were treated, namely the peripheral infestations escaping along the beach.

Fortunately these are not high priority species, as adequate control measures would require a significant input of resources.

Brooks Falls Trail and Platform

The gravel trail leading to Brooks Falls harbors scattered patches of pineapple weed, common dandelion, shepherd's purse and annual bluegrass. Small infestations of plantain in front of the vault toilet at the falls trailhead were fully treated in June and August. In July three individuals of common dandelion were discovered and removed, and annual bluegrass was inventoried, which is ubiquitous along the margins of the entire trail in low density. During return visits in August, multiple small infestations of pineapple weed and shepherd's purse were removed on the falls trail. Pineapple weed and shepherd's purse grow in high density around the base of both the Falls and Riffles viewing platforms. Pineapple weed has also infested the stream banks between the two platforms and covers the small island just downstream of the falls. In June the KATM EPMT and SAGA crew removed large carpets of pineapple weed from around the falls platform because all higher priority infestations had already been treated, and despite over 60 person hours of manual control, only a small percentage of the overall infestation was treated. In August a brief inventory found late phenology infestations of shepherd's purse growing along the shore line (Figure 5). Treatment effort removed approximately 50% of the late phenology shepherd's purse below the falls platform. High bear density at the falls in July makes treatment below the platforms impossible; therefore, treatment efforts were only attempted in early June and late August when the risk of bear conflicts was low. In 2010 bears were witnessed eating the flowering heads of pineapple weed and in 2011 the KATM EPMT discovered pineapple weed growing out of bear feces. Since the area surrounding the platforms is continually disturbed and bears further facilitate the dispersal of seeds, manual control efforts at this site are generally ineffective.

Figure 5. KATM EPMT crew member, Arielle Woods, using a GPS to inventory shepherd's purse below the Brooks Falls platform.

Lake Brooks side

Brooks Lake lies on the south side of Brooks River headwaters, approximately one mile (1.6 km) down a turnoff from the VTTS road. The lake is an access point for float planes, and in the vicinity lie NPS employee housing, a picnic area and maintenance yards. June surveys revealed that the fenced-in storage yard at the very end of the road is free of invasive plants, and a small infestation of pineapple weed and one plantain were removed from inside the electric fence around the mechanic's yard. The SAGA crew helped to remove pineapple weed along roads and footpaths of the BL-2 and BL-3 cabins in June, as well as a thick infestation behind BL-3 and a strip of plantain in front of BL-2. In July and August all plantain in front of BL-2 and shepherd's purse underneath the cabin were fully retreated with minimal effort.

Valley of Ten Thousand Smokes

VTTS Road and Trails

The Valley of Ten Thousand Smokes is a former river valley smothered in volcanic ash after the 1912 eruption of Novarupta, and much of the floor is still devoid of vegetation. The VTTS road, extending 23 miles from the BCDA through boreal forest and alpine tundra, is the only access point to the valley and represents a likely vector for invasive plants to spread into the backcountry (Mortensen et al. 2009). Since 2005, visual scans from a slow moving vehicle and surveys at vehicle pullouts have revealed pineapple weed, annual bluegrass and shepherd's purse at most pullouts, as well as along the entrance and fence at the sewage pit. The BCDA-side of the first river crossing is the furthest extent of pineapple weed and shepherd's purse as of 2011, and annual bluegrass likely exists past that point. The parking lot near the lower river platform contains pineapple weed and a small infestation of shepherd's purse, which was treated in July. So far, the infestations are well-contained within the pullout areas and have not spread along road sides, and they decrease in severity as distance from the BCDA increases. Although these species have relatively low invasiveness ranking, they are in close proximity to a large area of natural disturbance, and containment measures could be taken to prevent a significant extension of their range on the VTTS road.

In 2009, bird vetch was discovered near mile marker 13.5, which is the highest ranked invasive plant in the park due to its ability to grow into dense thickets. It was dug out in 2010, but its resistance to manual treatment and the potential for it to spread along the length of the VTTS road necessitated a more aggressive approach. The NPS prepared an Alaska Region Invasive Plant Management Plan environmental assessment. The Finding of No Significant Impact allows the use of herbicides where physical control methods are ineffective, following a structured decision tree and mitigation measures to reduce any potential adverse impacts to park resources (NPS 2010). Milestone herbicide was applied in June for the first time in KATM to this 0.02 acre patch of bird vetch (Figure 6). The site was revisited in July and no bird vetch was detected, and in August just four surviving individuals were found and removed.

Figure 6. Alaska EPMT Liaison Bonnie Million applies herbicide to the bird vetch infestation along the VTTS road.

In June, mouse-ear chickweed (petal length about equal to sepal length) was found on the valley road growing interspersed with native *Cerastium* plants (petals longer than sepals). This site, as well as the entire VTTS road margin, should be revisited next season to confirm the distribution of the *Cerastium* genus.

The Windy Creek trailhead, near mile marker 20, is one of the access points for visitors to reach the valley floor. Common plantain was discovered and treated a few hundred yards down the trail in 2005 (Bauder and Heys 2005), again in 2008 and 2009 by a single NPS employee (M.

Fitz, personal communication, September 2, 2011), and retreated in September 2010. The KATM EPMT was unable to return to reach the site in September 2011 to treat it, although it was observed by Mike Fitz at the end of August, thus it must be revisited in the future. A survey of the Margot Falls trail, starting near the halfway bathhouse, revealed only native vegetation, as did a survey of the trail leading from the VTTS road to the lookout point over Research Bay. The entire VTTS road should be monitored carefully in future years to ensure that present infestations do not significantly expand in range.

Gravel Pit

The gravel pit at mile marker five is the source for fill material used on the VTTS road and throughout Brooks Camp, as well as for the ongoing Valley Road Administrative Area construction project. A small infestation of narrowleaf hawksbeard (*Crepis tectorum*) and shepherd's purse was discovered in 2005 on the north side of the pit immediately left of the entrance, which has since been partially covered with building material. During 2011, fifteen individuals of narrowleaf hawksbeard were removed from this spot in June, seven more were removed in August, and another four in September. In comparison, in 2005, the initial year of treatment, 145 plants were removed.

Figure 7. A single bird vetch plant was discovered and treated at the gravel pit in 2011.

Scattered infestations of shepherd's purse were controlled to the left of the pit entrance, near the electric fence, and near the small gravel piles at the east side of the area. Common plantain was removed from the building material pile and electric storage fence in 2010 but was not detected in 2011, although future surveys in September are recommended due to plantain's late phenology. In 2010 bird vetch was removed from the material pile but it was not detected there in 2011, although a single individual in flower was found and removed in August from under a manhole cover in the electric fenced area (Figure 7). A line of pineapple weed was also inventoried along the electric fence. The outer perimeter of the pit was inventoried for escaping plants in August, with none found. Regular monitoring and control efforts must be conducted at the gravel pit to minimize the potential transport of contaminated fill material to disturbed areas in Brooks Camp.

Other VTTS Sites

Squirrel Camp, situated before the gravel pit, has been used for temporary contractor housing since the early 1990's (R. Sherman, personal communication, September 2, 2011). During July 2011, moderate infestations of pineapple weed and shepherd's purse around the entrance and cabins were found. This location should be closely monitored seasonally since its inhabitants regularly visit newly disturbed construction sites throughout Brooks Camp.

A new maintenance building was constructed in 2010 on the VTTS road before Squirrel Camp, surrounded by significant vegetation clearing. During 2011, a moderate infestation of pineapple weed was discovered in a cleared area on the far side of the building outside of the fence. In July,

76-95% of this infestation was treated and 96-100% was retreated in August, along with seven individuals of shepherd's purse. Although these species have relatively low invasiveness rankings, the significant extent of cleared land at this site poses the risk of it quickly becoming colonized by non-native species. It should therefore be monitored and controlled regularly, and restoration efforts are recommended.

Naknek Lake

Fure's Cabin

Fure's Cabin is a restored public use cabin situated on Naknek Lake's Bay of Islands, and is surrounded by a south-facing grass field. As the access point to the portage trail leading to Grosvenor Lake and the Savonoski Loop, it steadily receives small groups of patrons and boaters. The paths near the cabin are heavily infested with common dandelion, which has spread into the lawn, and annual bluegrass is also present on the paths. Dandelions at the head of the portage trail taper out within 10 meters, and only a few have escaped within the next 100 meters. There is a moderate infestation of shepherd's purse around the fire pit, where a single pineapple weed was also discovered and removed this year. Common mouse-ear chickweed was discovered for the first time in the park this year on the portage trail, and all six individuals were removed.

Initially, herbicide treatment of the dandelion infestation was planned for May; however, the late arrival of spring meant that access to the area was challenged by low lake levels and residual lake ice. In June, the SAGA crew spent a day removing flowering heads of common dandelion before they could go to seed in advance of a rescheduled herbicide treatment. The size and density of this dandelion infestation overwhelms manual control efforts, and the surrounding landscape presents ample opportunity for invasion. Due to the risk of this infestation spreading to other areas in the Bay of Islands or further along the portage trail, a more aggressive treatment method was required. Milestone herbicide was selectively applied to the dandelions over a 0.89 acre area. In July, the KATM EPMT returned to assess the effectiveness of the treatment. Many dandelions were dead or partially dried out, and the success of the herbicide will be fully revealed next season, although a substantial reduction in the dandelion infestation is already visible when compared to previous years (Figure 8). During this visit, 96-100% of the remaining dandelions along the paths and 76-95% in the lawn were controlled manually, as was 96-100% of the shepherd's purse at the fire pit. Two dandelions were found and removed along the portage trail within 100 meters of the outhouse. The length of the trail

Figure 8. Two years of manual treatment and one herbicide application have reduced the common dandelion infestation at Fure's Cabin.

was surveyed in July and found to be clear, and it should be noted that a small patch of the native, horned dandelion (*Taraxacum officinale* ssp. *ceratophorum*) is growing on the southern bank of Grosvenor Lake at the terminus of the portage trail.

Future control efforts will require multiple trips throughout the season starting in early June. Greater sun exposure at this site allows for earlier phenology, with the majority of dandelions in flower by early June and in seed by the end of the month. It is recommended that another herbicide treatment be planned for early June followed by manual retreatments in July. Since dandelion infestations in the BCDA are responding well to multiple treatments, day trips to Fure's Cabin could be incorporated into visits to Brooks Camp to retreat dandelions in August and September as well. If possible, reducing the area of brush cutting and/or allowing select trees to grow for replacement of existing trees would allow other species to naturally outcompete dandelions via shading. It is also advised to discourage the establishment of new social trails in the area and areas that have been trampled unnecessarily could be revegetated so that visitors do not unintentionally create new paths.

The Bay of Islands

KATM EPMT staff surveyed throughout the Bay of Islands in July along the edges of seven different islands that were accessible by boat and traversable by foot. Fortunately, no invasive plants were detected despite signs of human disturbance. Long distance transport of seeds via wind dispersal as well as steady visitation necessitates continued monitoring of the Bay of Islands to ensure the early detection of new infestations, especially given the proximity to known infestations at Brooks Camp and Fure's Cabin.

Margot and Idavain Creeks

Margot Creek in Research Bay and Idavain Creek west of the Bay of Islands are popular fishing destinations on Naknek Lake, and both were surveyed for the first time in August of this year. They are frequented by anglers who arrive via boat or floatplane, land on the beaches and walk the bear/social trails running along the creek banks. Surveyed areas at Margot Creek included the length of the beach, the large campsite and fire pit at the mouth, and the trail along the left side of the creek. The trail survey extended approximately one quarter mile (0.4 km) until the trail disappeared and bear interference halted survey efforts. No invasive plants were present in any of these areas. A survey of the beach at Idavain Creek revealed three individuals of pineapple weed, which were promptly pulled, and no invasive species were present as far as a mile (1.6 km) up the bear trail along the left side of the creek. The discovery of this infestation demonstrates the value of the EPMT's early detection and rapid response strategy and justifies continued monitoring of these sites. It is recommended that chest waders are used in future surveys here to facilitate river crossings and avoid bear encounters.

Lake Camp

As the only location in the park accessible by road, Lake Camp is the major access point into the park for anglers, boaters, local residents, and NPS staff. As such, Lake Camp is particularly vulnerable to the introduction of invasive plants found in King Salmon and Naknek (Mortensen et al. 2009). This road access also serves as the primary gateway for construction equipment, ideal vectors for transporting invasive plants, to Brooks Camp or the Bay of Islands. The dominant invasive species currently found at Lake Camp is sheep sorrel (*Rumex acetosella*), which lines the margins of all graveled areas including the upper and lower parking lots, along

road sides, paths, and escaping into grassy areas and undisturbed vegetation around the picnic benches and outhouses. Sheep sorrel, pineapple weed and shepherd's purse are found on the sandy beaches and riprap along the shores, specifically downstream of the boat ramp. Sparse infestations of pineapple weed and shepherd's purse were found along paths and in the margins of graveled areas, but in far lower density than sheep sorrel. In June the KATM EPMT and SAGA crew treated 51-75% of sheep sorrel in the upper parking lot, 76-95% on all paths, road edges, around the outhouse and picnic area, and all remaining individuals escaping along the beach (Figure 9). The KATM EPMT returned in July and August and focused their efforts on highly trafficked areas including the paths, perimeters of boat ramps, beaches and the outhouse, and retreated 96-100% of sheep sorrel, pineapple weed and shepherd's purse infestations in these areas. In September the KATM EPMT discovered a small patch of common dandelion at the base of the primary footpath, and treated 96-100% of the infestation.

Figure 9. SAGA crew rejoices after removing sheep sorrel infestations at Lake Camp.

During the 2010 field season, fall dandelion (*Leontodon autumnalis*) was discovered at Lake Camp, and a total of 111 individuals were removed. In 2011 the KATM EPMT performed intensive searches in July and August to remove all remaining plants before they went to seed. In July 96-100% of fall dandelions were removed from the picnic area, along paths and on road sides. After this treatment, fall dandelion was not detected at Lake Camp until September. During retreatment in September, 159 plants were removed from the picnic area and paths, and a new small infestation in the rocky area around the barge landing was discovered and fully treated. The fall dandelion infestation is still small, and therefore is a good candidate for potential eradication from the park, thus it should be closely monitored and aggressively treated in coming years.

Figure 10. Regular bear encounters make surveys in the Katmai National Preserve a challenging yet exciting experience.

Katmai National Preserve

In August the KATM EPMT travelled to the Katmai National Preserve to survey along Moraine and Funnel Creeks. These two waterways are known for their high bear densities (Figure 10) and excellent fishing, and are therefore highly trafficked by anglers, bear viewers and hunters. Prior to this season, no surveys for invasive plants had been conducted in this area.

Little Ku

Little Ku is a small lake surrounded by tundra vegetation, which is utilized as a float plane access point for anglers destined for Nanuktuk Creek. There is no beach and the vegetation

comes directly to the water line. In August the KATM EPMT stopped here briefly to survey and map along the edge of the lake and in the surrounding area before flying to the mouth of Moraine Creek. This survey revealed no invasive species and found little to no trace of human disturbance.

Mouth of Moraine Creek

The mouth of Moraine Creek at Kukaklek Lake is the terminus of many fishing and rafting trips and is a frequently utilized landing site for both float and wheeled planes picking up their clients. In August the KATM EPMT inventoried along the north side of Moraine Creek starting and proceeding up river over several days to a small lake referred to as the "pot hole," which is the starting point for many fishing and rafting trips. The banks of Moraine creek are covered predominantly by alder thickets, but periodically the bank opens into a meadow or rocky beach. Surveys focused on areas of high use, such as the landing strip above the mouth, camping areas and rocky beaches used for loading float planes. The majority of the area surveyed was minimally disturbed and free of invasive species. Annual bluegrass was discovered in two locations along this stretch of Moraine Creek; first at a severely trampled mud bank at the end of the portage trail from the pot hole where rafters and anglers stage their floats down the river. The second location was a well-worn float plane loading area approximately 0.5 miles (0.8 km) up from the mouth of Moraine Creek. Each infestation was less than three square meters and limited to locations of high disturbance, largely devoid of other vegetation. The KATM EPMT did not treat these infestations due to their low invasiveness ranking and uncertainty over their identification. Samples were sent to the AKNHP where it was positively identified as annual bluegrass. If feasible, future KATM EPMTs should revisit these sites to monitor and control the annual bluegrass infestations.

Crosswinds Lake

Crosswinds Lake is a highly trafficked access point for visitors arriving via plane to fish or observe bears on Funnel and Moraine Creeks. There are several camp sites and float plane landing areas set up surrounding the lake, including an NPS field camp at the northwest end of Crosswinds Lake used for backcountry patrols and bear monitoring. A well-worn trail leads from the main float plane landing area at the southeastern end of the lake to the confluence of Funnel and Moraine Creeks. Surveys were conducted around the perimeter of the lake and along the social trail leading to the confluence, and no invasive species were found despite severe disturbance in several areas.

Confluence of Moraine and Funnel Creeks

Of the areas surveyed in the preserve, the areas around the confluence of Moraine and Funnel Creeks are the most visited and highly impacted by human presence. At the confluence there are multiple camp sites where the vegetation has been heavily disturbed and numerous social trails branch out on the banks of Moraine and Funnel Creeks. The KATM EPMT conducted surveys from the confluence upstream along Funnel Creek and downstream along Moraine creek. Surveys up Funnel Creek began at a large campground and proceeded along a frequently used social trail leading to another float plane access point known as "Just Enough Lake." The trail primarily leads through alpine tundra with several observation points along the way. No invasive species were found despite frequent use of the trails. A large patch of the native, horned dandelion was found in the campsite located at the beginning of the social trail (Figure 11). Surveys down Moraine Creek began at one of the more prominent campsites downstream from

the confluence. In this campsite, a small infestation of annual bluegrass was discovered, but it did not appear to extend beyond the disturbed area surrounding a well-used fire pit. Again, the KATM EPMT did not treat these infestations due to their low invasiveness ranking and uncertainty over the identification. Samples were taken and sent along with those from the mouth of Moraine Creek, and were positively identified as annual bluegrass by the AKNHP. From this campsite, surveys continued downstream along social trails, which run along bluffs on the banks of the river. These trails are used by photographers, bear viewers and anglers to move quickly up or down stream. Surveys extended approximately 3 miles (4.8 km) downstream from the confluence, and no other invasive plants were discovered.

Figure 11. A native horned dandelion at the Moraine and Funnel Creek confluence.

Nonvianuk Lake and Alagnak Wild River

The Alagnak Wild River is a separate park unit under the administrative supervision of KATM. The majority of land is managed by the NPS, but multiple private inholdings complicate survey efforts in this area. In 2011, the KATM EPMT briefly revisited the Nonvianuk ranger cabin and trails leading from the river. Previously documented infestations of common dandelion was relocated, but both horned dandelions and what appear to be hybrids were also observed. Additionally, along the banks of the Nonvianuk River upstream from the ranger cabin where camping often occurs, the common plantain infestation was relocated along with new discoveries of annual bluegrass and mouse-ear chickweed. These infestations pose a threat of spreading further downstream on both the Nonvianuk and Alagnak Rivers. The infestations are small and could be eradicated with multiple treatments; therefore, return visits should be a priority in the coming years.

NPS backcountry law enforcement staff discovered an infestation of common dandelion on a private land holding at the confluence of the Alagnak and Nonvianuk rivers in early September (L. Hayden, personal communication, September 2, 2011). The infestation was photographed and a specimen was delivered to the KATM EPMT. Backcountry rangers have also suggested that private land holdings on the north side of the Nonvianuk River contain an infestation of common dandelion. Due to the late detection and logistic challenges, no efforts for mapping and removal were put into action this year.

Outer Coast

The Katmai coast has a long history of anthropogenic use including villages, canneries, farms and mining operations. Identifying and surveying areas of former use and disturbance is of primary importance as they may contain older and more severe infestations, which have previously been undocumented. Current anthropogenic uses of the coastal regions include bear viewing at Geographic Harbor and Hallo Bay, NPS ranger cabins at Amalik and Swikshak Bays and private lodges at Kaguyak and Kukak Bays. In a previous KATM invasive plant report from

2005, pineapple weed was documented growing in Kaguyak Bay on a trail from the beach to Hallo Bay Lodge, while no invasive species were documented at Hallo or Swikshak Bays (Bauder and Heys 2005). The 2010 KATM EPMT briefly visited Katmai Bay and Amalik Bay and encountered no invasive species (Shepherd and Bartley 2010). The outer coast is one of the most logistically challenging places to reach in the park and original efforts to survey at Hallo and Swikshak Bays were thwarted by inclement weather. During the 2011 field season, trips to Geographic Harbor, Amalik Bay, Kukak Bay and Kaguyak Bay were successfully completed.

Geographic Harbor

Geographic Harbor, a popular bear viewing destination, was the first coastal area that the KATM EPMT surveyed in 2011. The primary bear viewing area within the harbor has heavy tidal influence and is therefore frequently flooded, precluding the establishment of most invasive species. The vegetation throughout the rest of the harbor is largely alder thickets, which are also exclusionary to most invasive species. All 2011 surveys in Geographic Harbor revealed no invasive species.

Amalik Bay

During the 2011 season the KATM EPMT surveyed on Takli, Little Takli, and Mink Islands, which sit in Amalik Bay and were the home to an ancient village and a fox farm and trapping cabin from the early 1930's to 1940's (Clemens and Norris 1999). This history of human use draws frequent visits by NPS archeologists. The islands are both fairly dry with vegetation composed primarily of grasses, making them ideal sites for the establishment of invasive plants. Surveys around the perimeter of the island did not encounter any invasive species but were also unable to locate the site of the trapping cabin. Future surveys should attempt to locate the historic-use sites to ensure that no invasive species are present. Site visits to the Amalik Bay cabin in both 2010 and 2011 detected no invasive species.

Kukak and Kaguyak Bays

Surveys at both Kukak and Kaguyak Bays were performed this year for the first time since 2005. The KATM EPMT surveyed around two privately owned lodges, Katmai Wilderness Lodge in Kukak Bay and Hallo Bay Bear Camp in Kaguyak Bay while accompanying a cultural resource reconnaissance trip. Both lodges facilitate coastal tourism for bear viewing and fishing and pose a threat of moving invasive species into the more remote areas of the park. Survey work near Hallo Bay Bear Camp occurred from the coastal margin to the property boundary with no access to the private lands. Annual bluegrass, pineapple weed and common plantain were discovered on the trails leading from the beach to the lodge. No other invasive plants were detected in surveys in the coastal dune.

Figure 12. Common mouse-ear chickweed growing outside of planter boxes at the Katmai Wilderness Lodge.

KATM EPMT staff surveyed on and around the property of the Katmai Wilderness Lodge. Infestations of annual bluegrass were discovered growing along most paths in the camp as well as the path leading to the primary float plane landing area. Common plantain was found growing

in isolated patches on the float plane path as well as on the path leading from the lodge to the cabins. Common chickweed and common mouse-ear chickweed were documented growing outside flower boxes around the lodge (Figure 12). This is the first time these species have been found on the outer coast. The flower boxes contained a range of ornamental species, such as pansies, S*edum*, and *Salpiglossis*, which are not likely to overwinter and persist. In one box, however, European forget-me-not (*Myosotis scorpioides*) was planted. This species is considered invasive by the AKNHP and warrants a dialog with the lodge to discourage replanting. Surveys in the areas surrounding the lodge found no escaping non-native plants.

Other Lodges

There are a number of additional lodges on both federal and private lands within KATM's administrative boundary, which have not been surveyed by EPMT staff. The last surveys were conducted in 2000 and found that three invasive species, common plantain, common dandelion and pineapple weed, were present in disturbed areas around Grosvenor, Katmai, and Kulik lodges (Densmore et al. 2001). Common plantain was found at Katmai and Kulik Lodges, pineapple weed was found at Grosvenor and Katmai Lodges, and common dandelion was found at all three lodges. Given that these lodges do not receive frequent visitation by NPS staff it is difficult to survey at these locations. If permission can be obtained, EPMT staff should resurvey these areas in the future to examine how the infestations have expanded over the past decade. All additional bases for commercial operations should also be prioritized if permission can be obtained.

Aniakchak National Monument & Preserve

Aniakchak National Monument & Preserve (ANIA) is a remote, undeveloped and infrequently visited NPS unit, situated on the Alaska Peninsula approximately 130 miles south of KATM. Though it is a separate park unit, KATM assumes administrative duties for ANIA. Floristic inventories performed by the AKNHP in 2004 and field work conducted in the preserve in 2009 both detected no exotic species. During surveys preformed in 2010 by the AKNHP, common dandelion was discovered growing along the Aniakchak River (Shepherd and Bartley, 2010). Infestations were scattered along the river growing in undisturbed areas, which is an uncommon habit for dandelions in this region. These findings are disconcerting as ANIA is one of the least visited units in the National Park System. To date, no EPMT staff have verified these infestations or survey for others in the area due to its remoteness, infrequent visitation by NPS staff and the great expense of travel to ANIA. Efforts should be made in the coming years to visit ANIA and formally survey.

King Salmon

King Salmon is the main access point for visitors, vehicles, and equipment going into the park and is therefore the primary source for translocation of invasive species.

NPS Administrated Property

The NPS float plane dock is one of the major departure points for NPS staff going into the park. Small infestations of common dandelion, pineapple weed and shepherd's purse were found in the parking lot above the dock, which were treated multiple times throughout the field season. Removal of these infestations was prioritized so that they would not spread by employees or their gear traveling into the park. The narrowleaf hawksbeard treated in 2010 at the NPS float plane dock was not detected during the summer but a few plants were removed in October.

The NPS maintenance yard, which in previous years contained the worst infestations within NPS administered property in King Salmon, underwent a major construction project this season. Upon initial surveys in July, no invasive species were detected due to significant earthwork being conducted within the fenced area. A return visit in September found infestations of narrowleaf hawksbeard, common dandelion, fall dandelion, pineapple weed and shepherd's purse around the perimeter of the maintenance yard within 2 meters of the chain link fence. Particularly large infestations of narrowleaf hawksbeard and common dandelion exist at the entrance ways and around the fuel storage area. In September, 96-100% of the narrowleaf hawksbeard, fall dandelion and shepherd's purse infestations were removed from the perimeter of the maintenance yard. The disturbance caused during this construction project increases vulnerability to future infestations; therefore, this site should be monitored to ensure that the invasive species present do not overtake this area.

Oxeye daisy (*Leucanthemum vulgare*) was found and removed in front of the employee housing quadplex. Two large patches of alsike clover (*Trifolium hybridum*) were documented growing in the lawn behind the quadplex. Infestations of common dandelion, shepherd's purse and pineapple weed are frequent in the lawns and graveled areas around the NPS administrated areas, including the dormitory and various other staff accommodations.

Non-NPS Administrated Property

The Federal Aviation Administration (FAA) housing area is home to many full time federal government staff as well as several large infestations of invasive plants. In September the KATM EPMT visually surveyed for presence and expansion of invasive species documented in previous years. Significant infestations of alsike clover, narrowleaf hawksbeard, oxeye daisy and fall dandelion were observed growing along roadsides, with Ptarmigan Trail being the most heavily infested road (Figure 13).

Figure 13. Large infestations of alsike clover line the streets of the FAA housing area.

The marina building, where NPS boats and tailors were stored during construction in the maintenance yard, has infestations of narrowleaf hawksbeard, pineapple weed and shepherd's purse growing throughout the gravel parking lot. In July narrowleaf hawksbeard and select patches of shepherd's purse were treated in this area.

Surveys in June around King Salmon, which included the Air Force base, found significant infestations of common dandelion in the grassy areas along roadsides. Siberian peashrub (*Caragana arborescens*) was discovered growing along Jensen Road which leads from Pen Air to the Police department. Several large shrubs were also found in planter beds outside of a dilapidated Air Force building and Eddie's restaurant. Although this shrub has been planted in many locations in King Salmon and Naknek, it is not readily seeding in the surrounding areas like it does in many places in Alaska. Infestations of pineapple weed were found growing in the road margins and one small patch of sheep sorrel was documented on a small outlet road. European mountain ash (*Sorbus aucuparia*) and European bird cherry (*Prunus padus*) trees were observed in landscapes in King Salmon and Naknek. To date, neither species has been observed

spreading beyond cultivation. Large infestations of smooth brome (*Bromus inermis* ssp. *inermis*) were observed on Caribou Road behind Southwest Alaska Vocational & Education Center (SAVEC) and at FAA housing. In September what was thought to be bird vetch was discovered along the road leading to SAVEC, although the identification is questionable and is more likely a variety of marsh pea (*Lathyrus palustris*). Future KATM EPMT staff should attempt a positive identification when inflorescences are present.

In early September the KATM EPMT relocated a small bird vetch infestation originally documented in 2010 along Alaska Peninsula Highway, just before Flatnose Henry Road en route to Naknek. The infestation is dense but contained as no individuals were found extending outside the main infestation. Future KATM EPMT should attempt to obtain permission to treat this infestation so that it does not spread further along the road. The infestations of common tansy (*Tanacetum vulgare*) discovered in previous years along West Housing Road and behind the Johnson Drilling Company were not found this season. Common tansy had been treated in previous years through collaboration with Susan Savage of the U.S. Fish and Wildlife Service and future EPMT should follow up on these infestations to ensure they do not return. At the King Salmon Mall, infestations of narrowleaf hawksbeard, alsike clover and pineapple weed were observed around the parking lot area and King Ko staff housing, and foxtail barley, scentless false mayweed (*Tripleurospermum inodorum*) and oxeye daisy are present in planting beds lining the front of the office building.

Narrowleaf hawkweed was discovered for the first time this year in King Salmon, including a large patch next to the main runway inside the airport fence, as well as three individuals behind the Alaska Fish and Game sign on the Alaska Peninsula Highway. The three individuals behind the sign were treated, and in future years efforts should be made to obtain permission from the airport to treat the infestation within the fence.

Education and Outreach

Numerous education and outreach activities were conducted in the 2011 field season to promote community awareness on the impacts of invasive species. During May NPS seasonal training, an overview of the KATM EPMT program was presented to staff. Alaska Invasive Weeds Awareness Week in June provided an opportunity to educate NPS employees and Bristol Bay residents. A handout identifying invasive plants common in the King Salmon area was displayed at the visitor center along with a children's coloring book. A story book explaining invasive plants was read to a group of children on Botany Day. "Caution" posters presenting images of invasive plants and suggestions for preventing their spread were displayed in multiple public locations in King Salmon and Naknek to disseminate this information to the wider community (Appendix B). In June and August, the KATM EPMT compiled a newsletter sent to all KATM employees detailing our field work and providing descriptions of invasive plants threatening the park.

To facilitate active involvement in the prevention of invasive plant introductions, boot brushes with framed informative signs were installed permanently at the NPS float plane dock, Lake Camp boat ramp, Brooks Camp Visitor Center, and the Three Forks Visitor Center at the end of the VTTS Road (Figure 14). These signs alert visitors that a common method of seed transport is via personal gear and equipment, and reminds them to remove all plant material before entering a new area within the park and beyond (Appendix C). A pamphlet containing species-specific information was designed in conjunction with the boot brush signs, for which display cases should be installed early in the 2012 field season.

Education and outreach activities should be pursued each season to encourage public awareness and discourse about invasive species, as knowledge is an essential tool in combatting their negative impacts on native ecosystems.

Figure 14. NPS ranger Kara Lewandowski shows off the KATM EPMT's new boot brush sign at the Brooks Camp visitor center.

Gypsy Moth Traps

Invasive pests threaten biological diversity in a similar manner as invasive plants do. Introduced insects can spread aggressively, displace native species, and have the potential to cause economic harm. The gypsy moth poses a significant hardwood defoliation threat to Alaska's forested ecosystems, and a structured detection and monitoring system for multiple species has been in place for several years. Recreational vehicle traffic is thought to be the primary mode of gypsy moth transport, but potential introductions via shipping ports are of increasing concern, making the Bristol Bay's maritime shipping ports vulnerable. The only species of gypsy moth currently detected in Alaska is the European gypsy moth (*Lymantria dispar*) and no known reproducing populations have been established (USFS 2010).

Figure 15. KATM EPMT staff Peter Frank and Arielle Woods set a gypsy moth trap behind the dock in Naknek and records its location.

In accordance with the Alaska EPMT's early detection and rapid response strategy, a gypsy moth trapping system has been incorporated into our monitoring efforts. The sticky traps contain a lure baited with synthetic versions of the species' pheromones, which can also apply to Asian gypsy moths (*Lymantria dispar* ssp. *japonica*). Other non-native moth species may respond, including non-target species, although records are inconclusive (Lance 2006). Traps were installed in hardwood trees in four locations: behind the law enforcement cache at the NPS float plane dock, in the yard between the NPS dorm and maintenance building, in Whitney Rapp's

backyard, and near the main shipping port in Naknek (Figure 15). Initial installation occurred in June, trap contents were checked at each site in mid-July, early and mid-September, and the traps were disassembled in late September. GPS data was collected during each site visit. Various insects, including native moths, were captured in the traps, but no gypsy moths were present. Given the low time commitment required by this monitoring program and its significant detection value, it should continue in future seasons.

Other non-native moths

A notable insect defoliator present in Alaska is the geometrid moth. Multiple species exist, the most destructive being the native Bruce spanworm (*Operophtera bruceata*) and the introduced autumnal moth (*Epirrita autumnata*). They occur in various locations in South Central Alaska, and are working their way down the Kenai Peninsula. An outbreak can involve the defoliation of hundreds of trees and shrubs by the caterpillars over numerous years, ending with a crash in the caterpillar population. It typically takes several years of continuous defoliation to kill native deciduous trees and shrubs, especially if the ability to produce a second crop of leaves per season is maintained, although extreme weather conditions may have a greater impact on compromised trees (Rasy et al. 2011). Caterpillars were observed in KATM in 2011 and have caused defoliation at Brooks Camp and in the Bay of Islands, although the species and their nativity have not been established (W. Rapp, personal communication, September 2, 2011). It is unknown whether geometrid moths were accidentally brought to Alaska by humans, or how climate change will affect outbreaks. The damage to native vegetation precipitated by geometrid moths demonstrates the importance of monitoring for other defoliating pests like gypsy moths, whose presence could potentially exacerbate preexisting destruction. Annual monitoring of defoliation and investigation of caterpillar and moth species present in KATM can inform the decision of whether to take management action such as pesticide application.

Prevention

Limiting the spread of invasive plant seeds is a more cost-effective means of management than treatment options, affirming prevention measures as key components in any invasive plant management strategy. This season, thorough inspections of equipment and vehicles destined from Lake Camp to Brooks Camp were conducted to preemptively combat invasive plant introductions to newly disturbed areas. Planning with construction contractors included the recommendation that inspections take place in King Salmon or Naknek, since Lake Camp is within park boundaries, has no water source, and failure to pass would require equipment to return to town for further cleaning. The initial inspection occurred in October at Lake Camp, and subsequent inspections took place at the cleaning facilities in Naknek over multiple days. KATM EPMT staff thoroughly checked all joints and crevices that could harbor dirt or plant material,

Figure 16. KATM EPMT coordinator Whitney Rapp inspects a front end loader for invasive plant material.

paying particular attention to undercarriages and chassis (Figure 16). Equipment that did not pass initially was re-cleaned and some equipment needed to be re-cleaned as many as three times before passing inspection. For this reason inspectors should arrange to be present before the first cleaning in order to inform the cleaning crew of specific expectations. Also all future inspections should take place at the cleaning facilities to avoid the transport of contaminated equipment to Lake Camp, and to eliminate unnecessary travel. Invasive plant flagging tape was used to indicate approval. These inspections involve modest preliminary measures that potentially eliminate the need for years of future control efforts.

In 2011, there was internal resistance to have NPS vehicles cleaned and inspected when bound for Brooks Camp. One reason cited was the lack of a containment area for dirt, debris, and residual oils being washed off of vehicles. Efforts in 2012 should be made to ensure that NPS vehicles conform to the same policies imposed on contractors.

Restoration

Restoration is another key element in preventing the establishment and spread of invasive species. Many human activities within the park, including anything from trampling to major construction, cause damage to native plant communities. When left unrestored, these disturbed areas become ideal for the invasion and establishment of invasive species. With new construction and renovation projects scheduled for KATM, it is crucial that restoration and revegetation be included within future project proposals so that disturbed areas can return to their natural state without hindrance by invasive species. Consequently, the 2011 KATM EPMT has created a citable document which outlines different disturbance scenarios and provides strategies for revegetation and restoration.

Reseeding is a simple method for revegetation and has had success in mildly disturbed areas in the park. Efforts to establish a seed bank for KATM were stalled by the cold summer and very poor overall seed production. In coming years, when feasible, efforts should be made to collect and preserve seeds for future revegetation projects.

Recommendations for the 2012 Field Season

Volunteers

The SAGA AmeriCorps youth crew's two week visit accounts for a significant input of control person hours and is thus a valuable resource in attaining the KATM EPMT treatment goals. Lessons can be learned from past successes as well as logistic challenges encountered. The primary challenge in 2010 and 2011 was the timing of their visit with respect to plant phenology. The SAGA crew's arrival in early June (6/10 in 2011 and 6/8 in 2010) was early enough in the season that many invasive plant infestations were still sparse and limited to small rosettes. The majority of dandelion, plantain and shepherd's purse in the BCDA were treated within the first few days, meaning the remainder of the time at Brooks Camp was spent less efficiently by scanning for plants that had been overlooked, or removing lower-priority species such as pineapple weed. As a result, a decision was made to transport the crew to King Salmon earlier than anticipated to work on the more pervasive sheep sorrel infestation at Lake Camp. If possible, future volunteer crews should be scheduled for the end of June, July or early August when plants are visible and abundant but have not gone to seed, although campground availability is unlikely until late July or August. Otherwise, arrangements for the crew to return to King Salmon early should be made in advance, taking into account the need for approval of camping accommodations on NPS property and availability of vehicles to shuttle the crew to Lake Camp.

Given the tedious nature of invasive plant removal, maintaining productivity throughout the workday can pose challenges, especially when working with a youth crew. Multiple techniques can be employed to keep crew members on task and ensure time is being spent efficiently. Relocating to a new site every few hours to relieve monotony and maintain focus worked particularly well. Dividing a site with transect lines and assigning a section to a crew member can prevent the same area from inadvertently being searched by multiple people, and it makes it easier to assign tasks and visualize progress. Another method is doing a sweep of a site such as a lawn or the campground in which each crew member continues forward in a straight line of arm's length. It is both the SAGA crew leaders' and KATM EPMT's responsibility to supervise youth and ensure they do not wander off or sit complacently for long periods of time.

Various methods were employed to boost interest and morale throughout the visit. Participation in the crew's morning stretch circle promotes camaraderie and focus among the group. Educating the crew on the impacts of invasive plants and the value of preventive measures can make work more meaningful. In order to spark the crews' interest and facilitate discussion, an invasive plant slide show and DVD were presented to them before the first day of work. Since many crew members may hold interest in science and natural resource careers, it is suggested to arrange visits in the field by various KATM employees, especially interpreters and law enforcement, for informal question-and-answer sessions. This proved to be a highly-valued educational tool in 2011. During the workday, word games and contests were incorporated to keep the workers stimulated while performing the monotonous task of pulling weeds. Competitions such as the longest root for dandelions (beware of crew members excavating large holes), the longest rhizome for sheep sorrel, or the first person to pull x number of weeds (beware of crew members collecting plants while leaving roots behind), provided an incentive to crew members to work hard. Katmai paraphernalia was awarded as prizes at the end of the visit to the winners of various competitions. Offering trips to the VTTS or Fure's Cabin for the most productive or efficient

workers can also be used to bolster productivity. In 2011 a weekend trip to the Ukak Falls and confluence in the VTTS provided excellent motivation for the crew as well as an opportunity for the SAGA crew leaders to work on team building exercises.

Phenology

Varying species phenology complicates control efforts and must be accounted for when planning field work. The differences in phenologies between invasive species are not only interspecific, as site-defined intraspecific phenologic variability was observed as well. During the June trip to Brooks Camp many infestations described or mapped in previous years were not detected or were present in an immature and unidentifiable state and therefore could not be treated with the SAGA crew. On return trips to the BCDA in July and August these infestations had reemerged. The general phenologic variability in the most prevalent species is as follows:

- Sheep sorrel and common dandelion can be easily detected from late May through September. Common dandelion shows specific resilience to site-specific variability. For example, common dandelion can be found in June at both the Brooks Camp cultural site, a highly disturbed area with a favorable south-facing slope, and the campground, a heavily-shaded area with substantial competition from native plants.

- Pineapple weed also has a fairly predictable phenology. In all locations it could be found in June, except along the Brooks Falls and cultural site trails, where it was not detected until August. It is likely that heavy shading impacts the phenology of pineapple weed in these locations.

- Shepherd's purse is one of the more confounding species as its phenology can vary greatly from site to site. When young it is very difficult to distinguish between shepherd's purse and the native lyrate rock cress. It can be found as early as June on the closed trail and on the margins of many gravel paths through the BCDA. Examples of late phenology infestations of shepherd's purse include the spit road, Brooks Falls trail, below the Brooks Falls platform, the cultural site and around perimeters of buildings in the BCDA. When stem leaves are present, shepherd's purse can be distinguished from the native rock cress by its sessile and sagittate leaves, whereas lyrate rock cress leaves are stalked and only occasionally sessile. The seed pods of shepherd's purse are obvious heart-shaped silicles, while those of lyrate rock cress are long, thin siliques.

- Common plantain also displays a variable phenology. In graveled areas and waste places, in such as in the BCDA the parking lot outside of BL-3 or the gravel pad near the generators, common plantain can be found in early June and will emerge in waves throughout the growing season. Areas with limited sunlight and heightened competition, such as trampled areas in the campground and along the Dumpling Mountain and Windy Creek trails, common plantain is very difficult to detect until late July or August. The 2011 KATM EPMT struggled to find the large infestations of plantain previously described in the campground during surveys in June and July but during a return visit in August were shocked and dismayed at the huge infestations they found. These infestations may have arrived later in the season if they were first year plants, which would indicate an effective treatment in 2010.

- Even though it is normally considered a winter annual, narrowleaf hawksbeard infestations in KATM usually display a late phenology and can be difficult to find before July, as the plant will only be a very small rosette. From late July to August is the optimal time to survey for and treat narrowleaf hawksbeard before it goes to seed.

- Bird vetch will begin to come up in June but has not been observed in flower before August. This species is distinguishable from other natives by its foliage and lack of winged stems.

Disposal Methods

The disposal of plant material that accumulates during the field season has been a significant issue for the KATM EPMT over the past two years. Several disposal methods have been investigated and attempted and most have been meet with complications and only moderate success. The 2010 KATM EPMT staff attempted burning plant material but found that the burn barrel they built from an old oil drum was inefficient and unhealthy to both the environment and themselves. Alternately, they attempted to use a kitchen oven to heat the plant material to 300° Fahrenheit in order to sterilize the seeds, leaving behind only compostable biomass. This method is feasible but is time consuming due to the slow heating process and the overwhelming amount of plant material. It could be used to heat bags which have undergone significant decomposition and will not readily burn.

The challenge of disposal for the 2011 KATM EPMT staff was magnified due to residual plant material left from the previous field season. The EPMT contacted the local dump to inquire about several methods of disposal at their facilities, including burying at a depth of 15 feet, burning in an incinerator and burning in a wooden pallet fire, but officials from the dump were unable to aid in any disposal measures. Therefore the KATM EPMT again resorted to burning the plant material.

A specialty burn barrel with perforated metal sides to improve air intake was ordered and assembled. Cardboard collected from NPS employees, wooden pallets obtained from the dump, and used ethanol and spare diesel were used to fuel the burn. The manufacturer's instructions suggested that a fire should be built on top of the material, allowing the coals to incinerate downwards. This method was ineffective since the plant material would fall to the base of the barrel and restrict air flow at the base of the fire. This method would leave large masses of unburned material, still containing viable seed, (Figure 17) at the end of each burn.

Figure 17. If plant material is not fully incinerated during the burning process, invasive plants may still germinate as shown above.

In an effort to separate the base of the fire from the plant material the burn barrel was placed on a stone platform allowing heat and flames to escape up through the plant material, drying and burning it simultaneously. This method, while slightly more efficient than the first, still required huge inputs of wood, cardboard and diesel, roughly one gallon of fuel per five bags of plants, to fully dispose of the unwanted plant material (Figure 18). The plant material which has accumulated over the past two seasons has heavily decomposed, contains large amounts of residual soils and was often saturated, and when it was put in contact with fire it did not fuel the fire but rather extinguished it. Burning plants immediately or soon after removing them to prevent decomposition and water log is ideal, but the cool and rainy climate in King Salmon provides few summer days during which burning is a viable option. Several other options were considered but never acted upon during the 2011 field season, and should be further investigated in upcoming years:

Figure 18. KATM EPMT crew member Arielle Woods stokes the fire in the burn barrel.

- Purchasing a large container, such as a fish tote, that could be used to store plant material for several years until it decomposes fully and is no longer viable, at which point it can be disposed of at the dump.

- Finding a dry location where plant material could be spread out on screen shelves or in screen bags to dry would improve the burning process significantly and allow for the removal of residual dirt from plant roots which would also greatly improve the burning process.

- A wood fired stone or brick kiln could be constructed to heat and sterilize plant material. An insulated structure such as a kiln could heat much larger quantities of plant material than the kitchen oven which has previously been used. This method would be logistically complicated to achieve due to costs and the space requirements.

- The plant material could be packaged and shipped to Anchorage or Seattle where it could be disposed of in a larger dump or incinerated. While expensive, it requires limited man hours and allows more time to focus on other work priorities.

The disposal of plant material is a significant problem for the KATM EPMT with no simple or clear solution; future staff should experiment with different methods suggested above to improve efficiency. Future KATM EPMT staff should also begin the disposal process immediately upon arrival in King Salmon and should burn or sterilize all plant material soon after it is removed to avoid plant decomposition and future backups.

Suggested Schedule

April: Participate in all necessary NPS training sessions. Review the Alaska EPMT field protocol and become familiar with the identification of native and non-native plants found in the park.

May: Make initial trip to Brooks Camp and begin to treat early phenology infestations, such as dandelions at the cultural site, campground and around the lodge and visitor cabins. Begin prioritizing, planning and scheduling trips for the field season. Start treating sheep sorrel at Lake Camp. Attend the Alaska EPMT spring training.

June: Begin intensive treatment efforts in the BCDA. Treat common dandelion and shepherd's purse throughout the BCDA. Retreat dandelions at Fure's cabin and bird vetch on VTTS road. Monitor and control infestations of common plantain at the generators and at BL-3 cabin. Start planning outreach and education activities, such as programs at the visitor center or activities at Naknek Fishtival. Control sheep sorrel at Lake Camp, specifically those individuals present on the trails, around the outhouse and escaping on the beaches near the docks. Inspect all NPS vehicles before they are barged to Brooks Camp for the summer. Install brochure holders at designated boot brush locations.

July: Attempt surveying trips to other locations in KATM, including the outer coast, Nonvianuk ranger cabin, and the preserve. Revisit Brooks Camp to control infestations in the BCDA. Monitor and treat common plantain infestations on the Dumpling Mountain and Windy Creek trails. Survey the VTTS road, checking at the five mile pit for bird vetch and narrowleaf hawkweed, and at mile marker 13.5 for bird vetch. Continue treatments of sheep sorrel at Lake Camp.

August: Continue control efforts in the BCDA. Treat and monitor late phenology shepherd's purse and pineapple weed growing on the Brooks Falls trail. Retreat any infestations found in or behind the new Brooks Camp maintenance building. Monitor and control the bird vetch and narrowleaf hawksbeard on the VTTS road and at the five mile pit. Make positive identification of mouse-ear chickweed found on the VTTS road. Resurvey Margot and Idavain Creeks looking for pineapple weed on the beaches. Begin to collect native seeds from Brooks Camp. Treat and monitor fall dandelion at Lake Camp.

September: Make final trip to Brooks Camp to collect seeds (if feasible) and treat any late phenology infestations, such as the common plantain in the campground and on the Windy Creek trail. Work on writing the end of season report. Finalize GPS data and herbarium specimens collected throughout the summer. Treat any remaining fall dandelions at Lake Camp. Monitor narrowleaf hawkweed and narrowleaf hawksbeard around King Salmon and revisit sites where common tansy was found in 2010. Attempt to dispose of remaining plant material collected during the field season.

October: Finalize and submit the end of season report. Make inspections on any contractor vehicles or equipment traveling to Brooks Camp (as well as throughout the season). Continue disposal efforts for remaining plant material.

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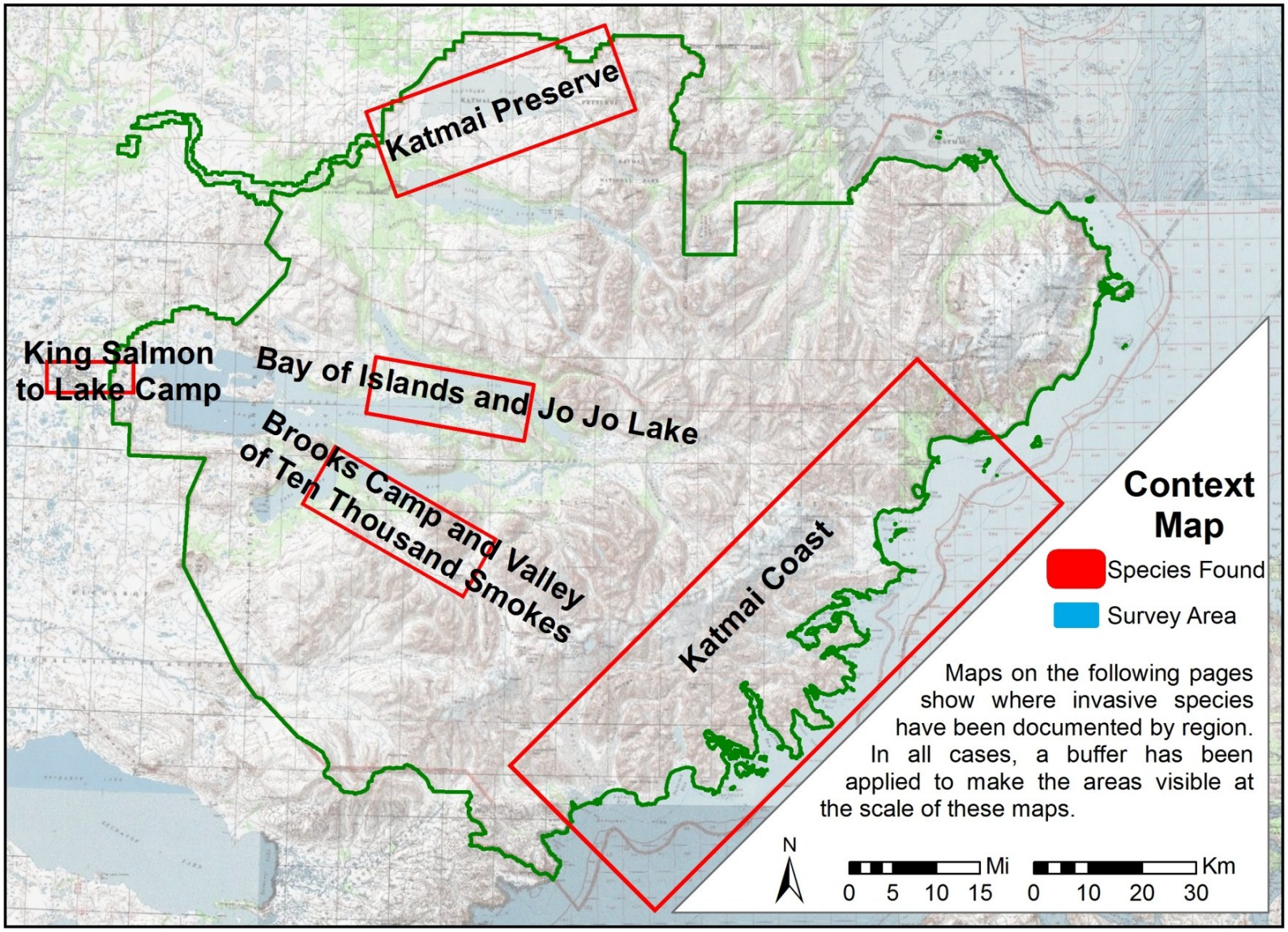
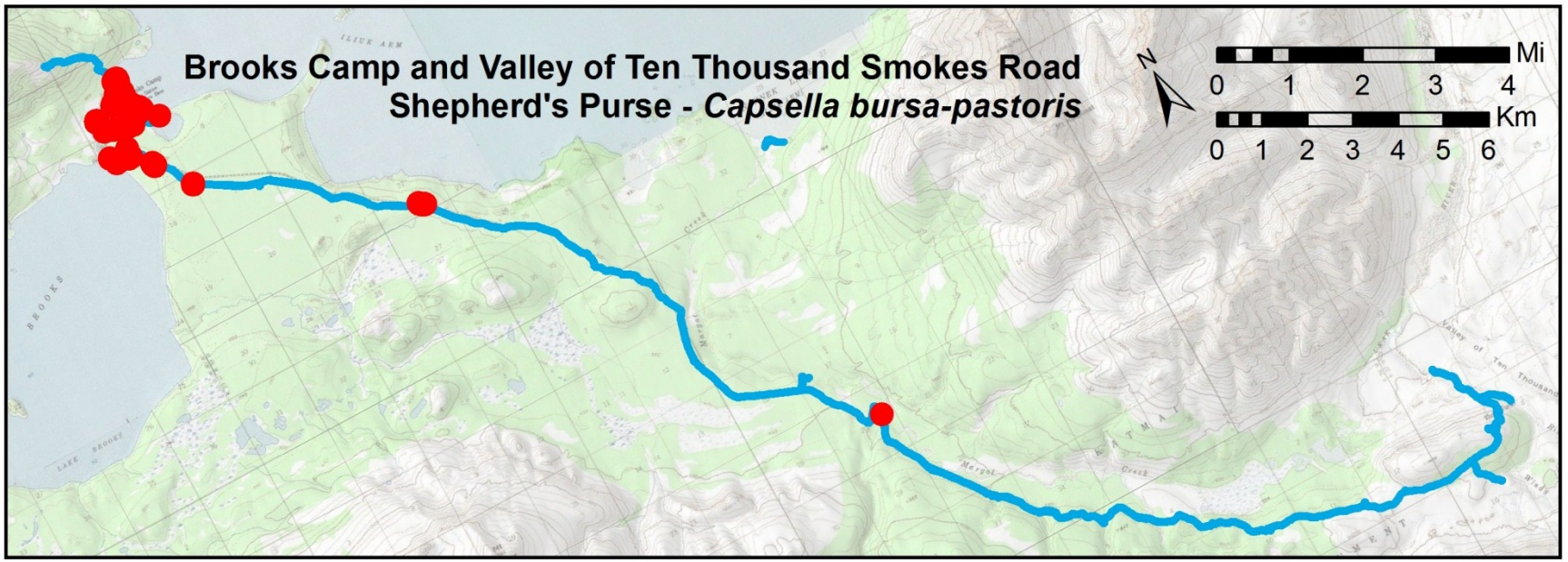
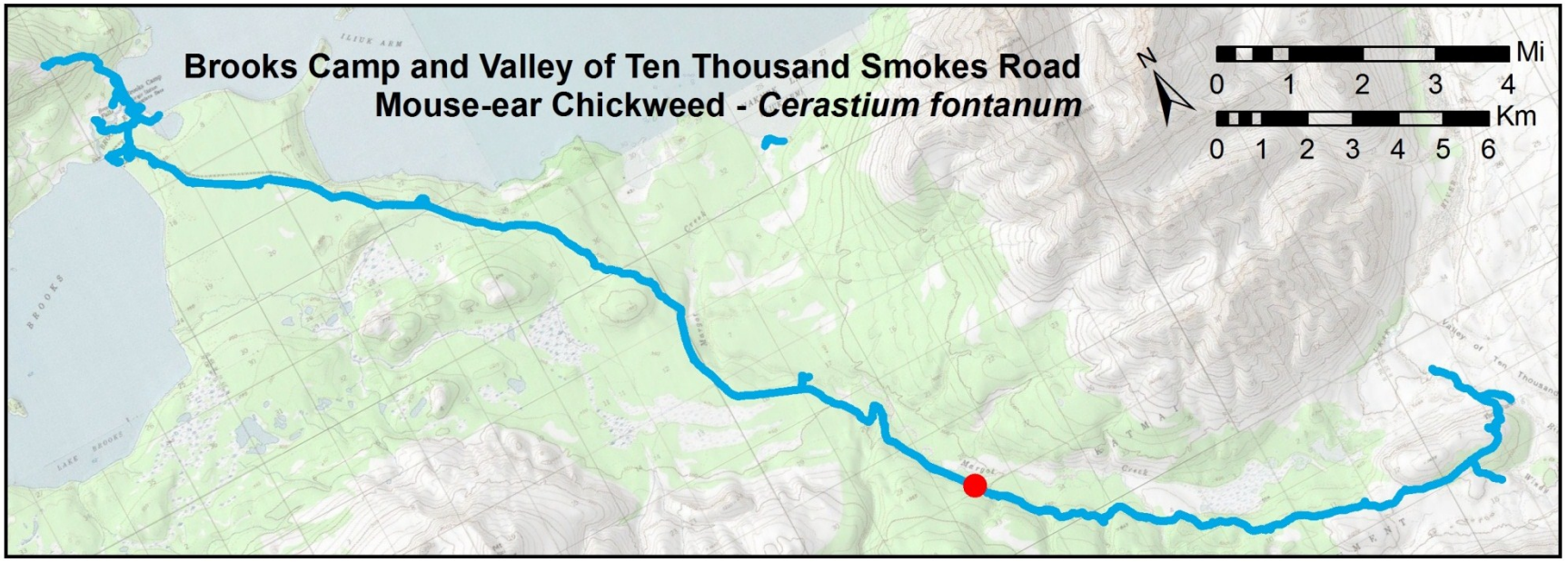
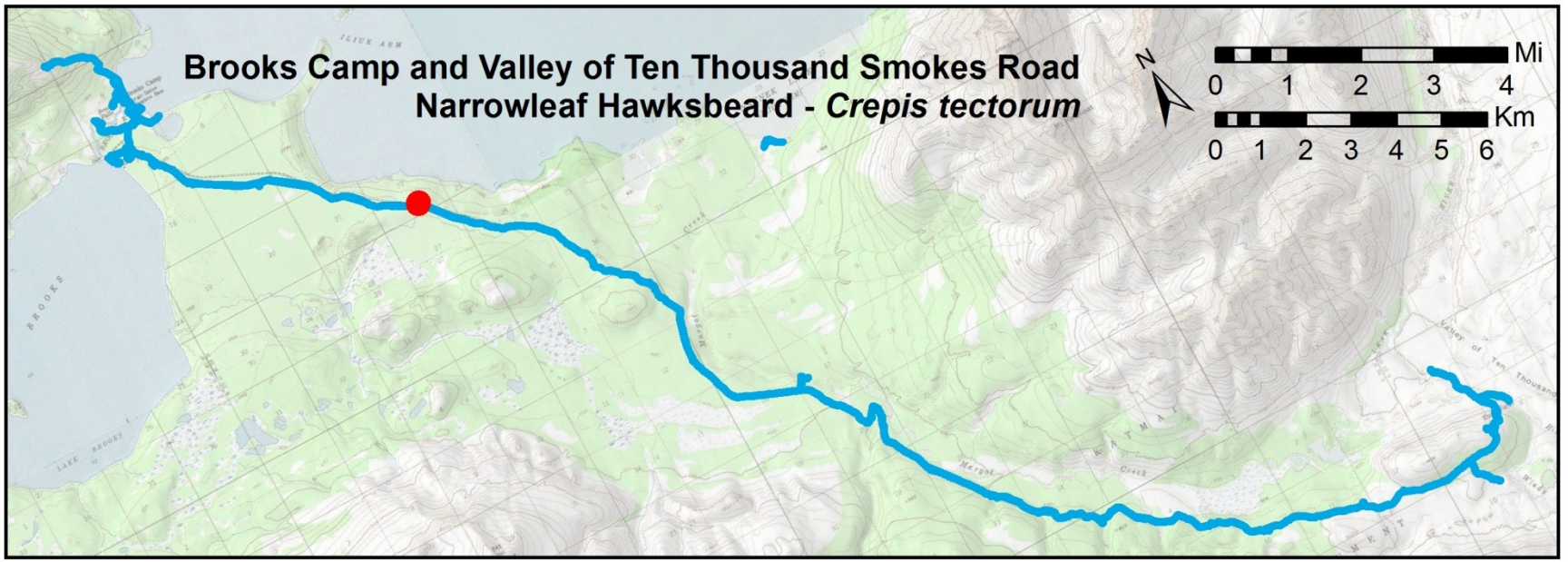
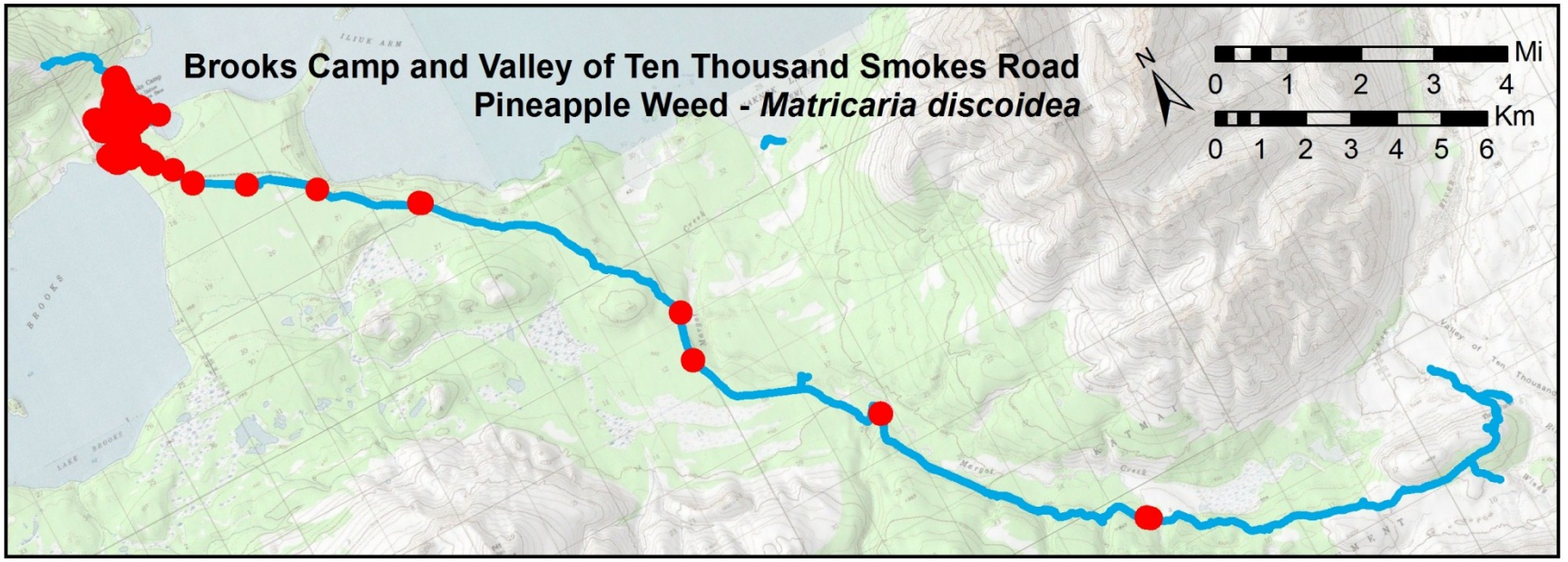
Appendix A


Katmai Preserve
King Salmon
to Lake Camp
Bay of Islands and Jo Jo Lake
Brooks Camp and Valley
of Ten Thousand Smokes
Katmai Coast
Context
Map
Species Found
Survey Area
Maps on the following pages show where invasive species have been documented by region. In all cases, a buffer has been applied to make the areas visible at the scale of these maps.
N
Mi
0 5 10 15
Km
0 10 20 30

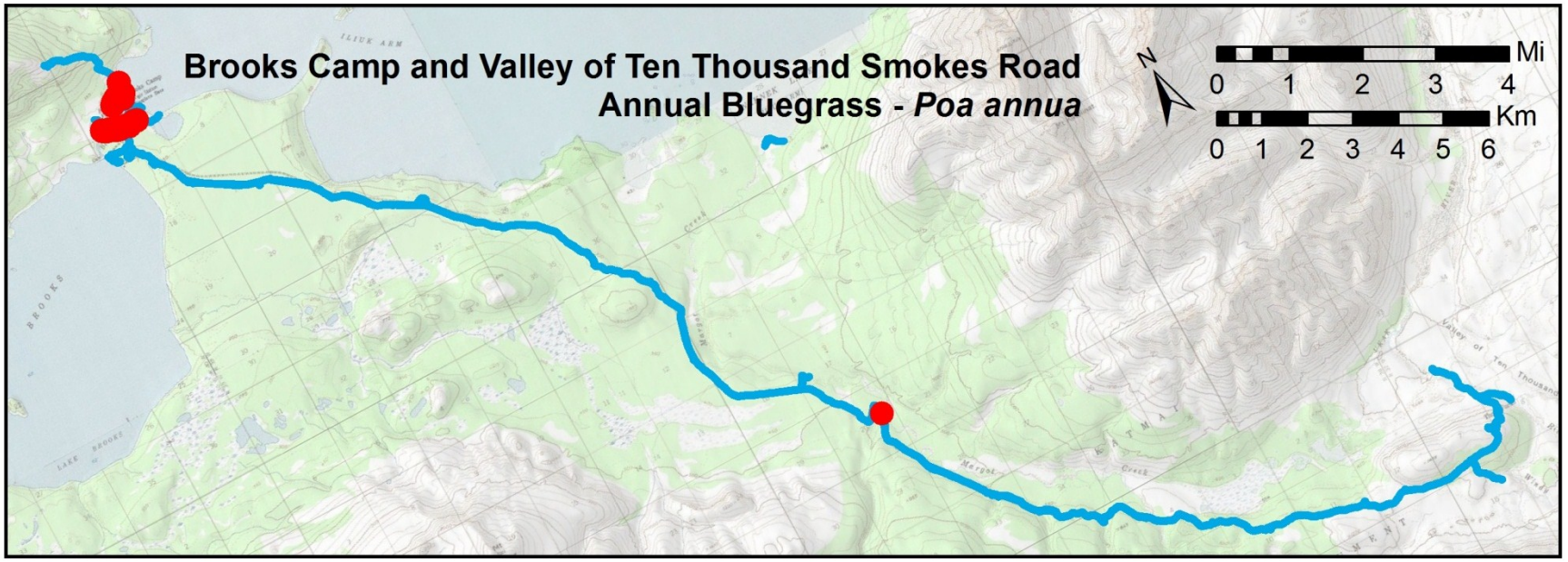

Brooks Camp and Valley of Ten Thousand Smokes Road
Shepherd's Purse - Capsella bursa-pastoris
N
Mi
0 1 2 3 4
Km
0 1 2 3 4 5 6


Brooks Camp and Valley of Ten Thousand Smokes Road
Mouse-ear Chickweed - Cerastium fontanum
N
Mi
0 1 2 3 4
Km
0 1 2 3 4 5 6


Brooks Camp and Valley of Ten Thousand Smokes Road
Narrowleaf Hawksbeard - *Crepis tectorum*
N
Mi
0 1 2 3 4
Km
0 1 2 3 4 5 6


Brooks Camp and Valley of Ten Thousand Smokes Road
Pineapple Weed - *Matricaria discoidea*
N
Mi
0 1 2 3 4
Km
0 1 2 3 4 5 6


Brooks Camp and Valley of Ten Thousand Smokes Road
Common Plantain - *Plantago major*
N
Mi
0 1 2 3 4
Km
0 1 2 3 4 5 6


Brooks Camp and Valley of Ten Thousand Smokes Road
Annual Bluegrass - *Poa annua*
N
Mi
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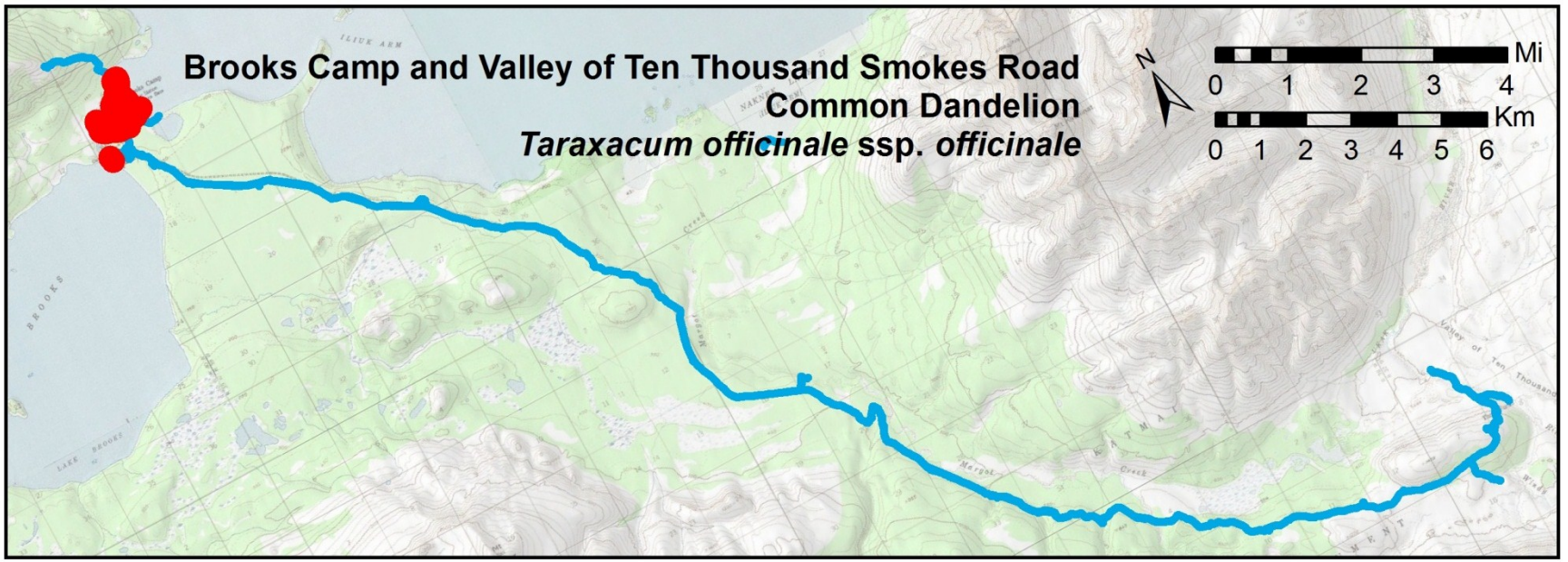
Km
0 1 2 3 4 5 6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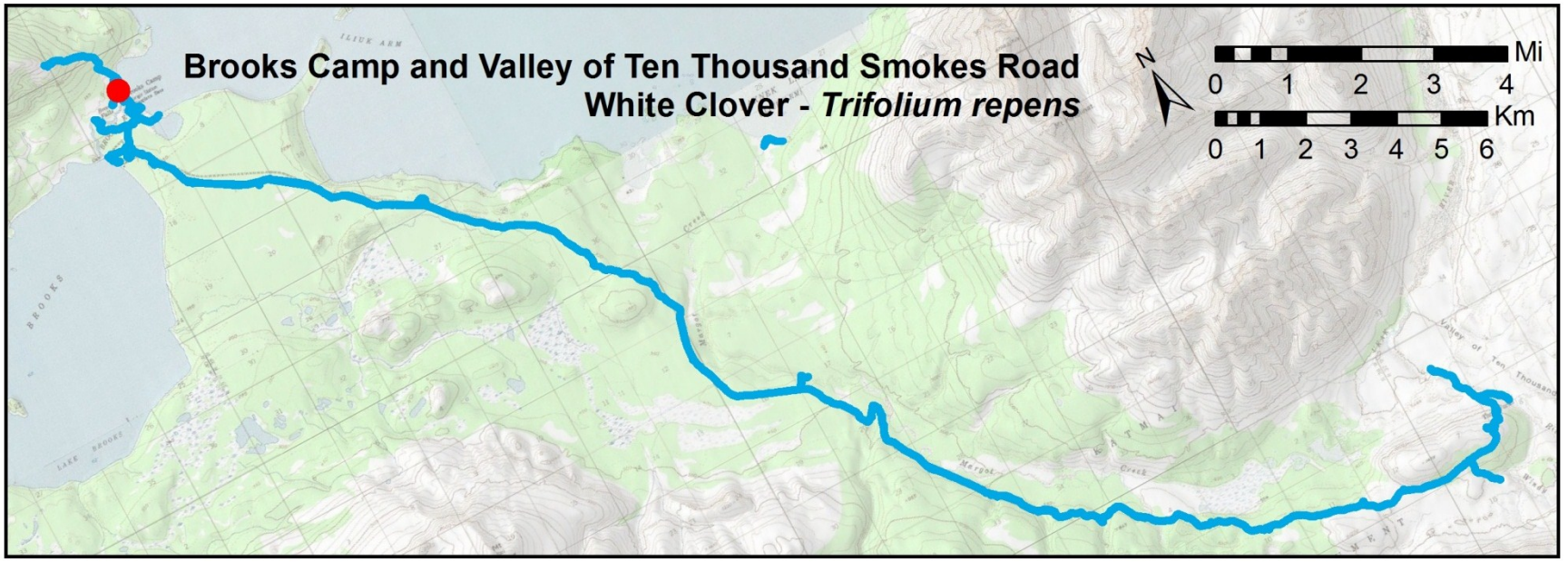
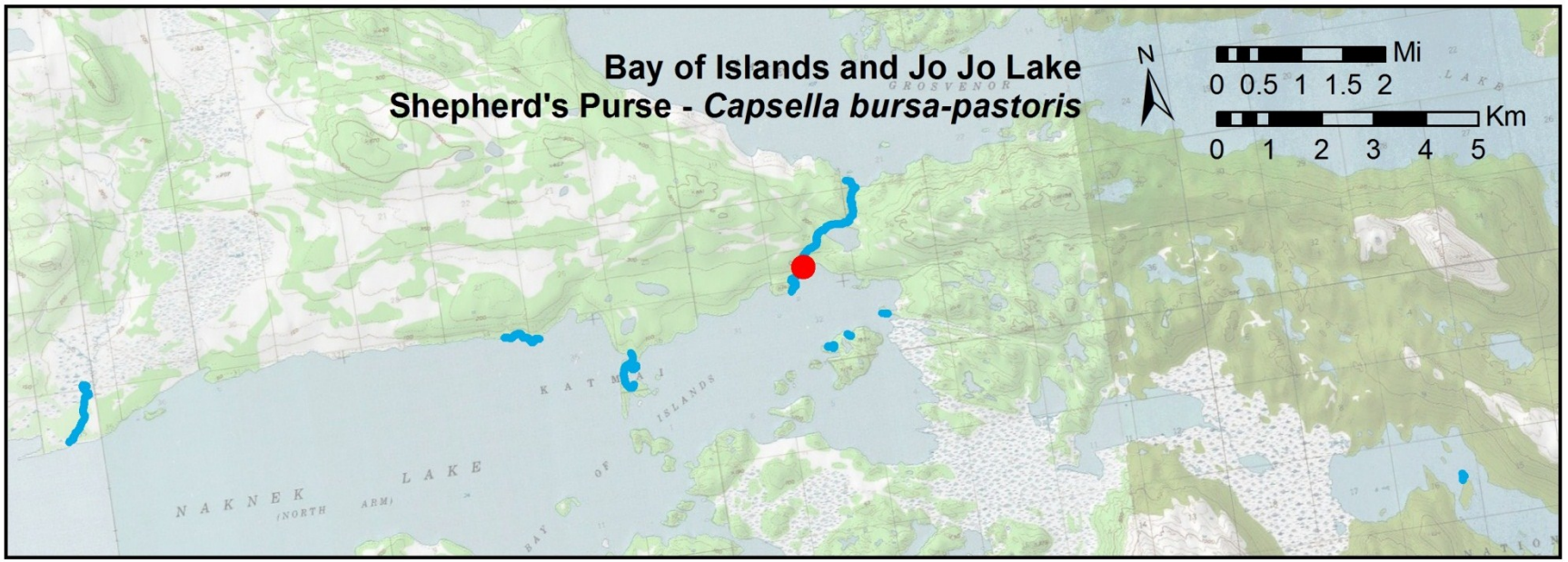
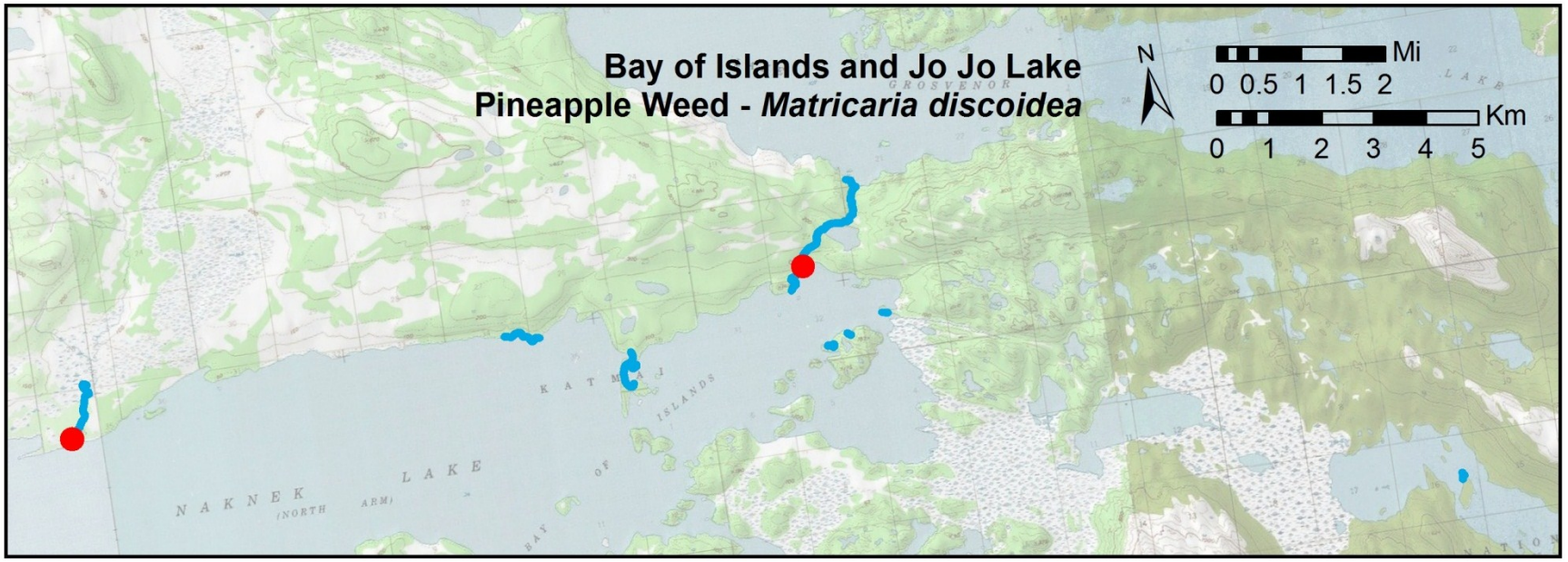
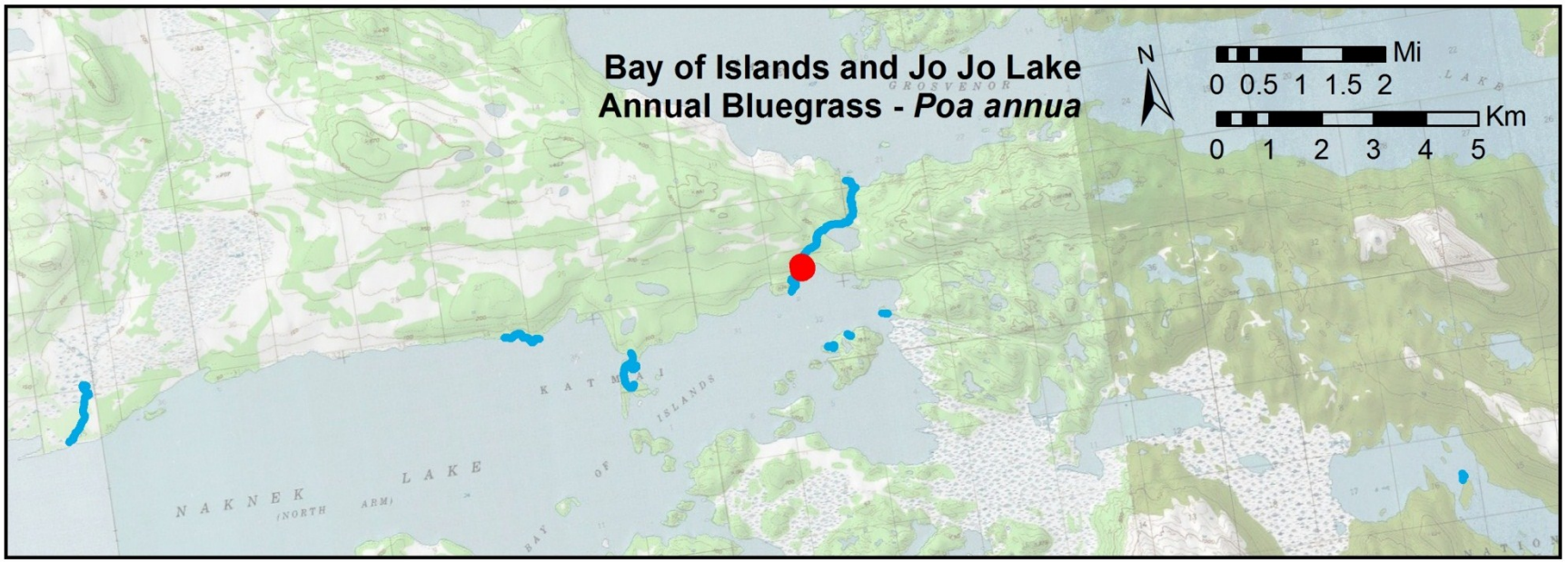
Common Dandelion
Taraxacum officinale ssp. *officinale*
N
Mi
0 1 2 3 4
Km
0 1 2 3 4 5 6

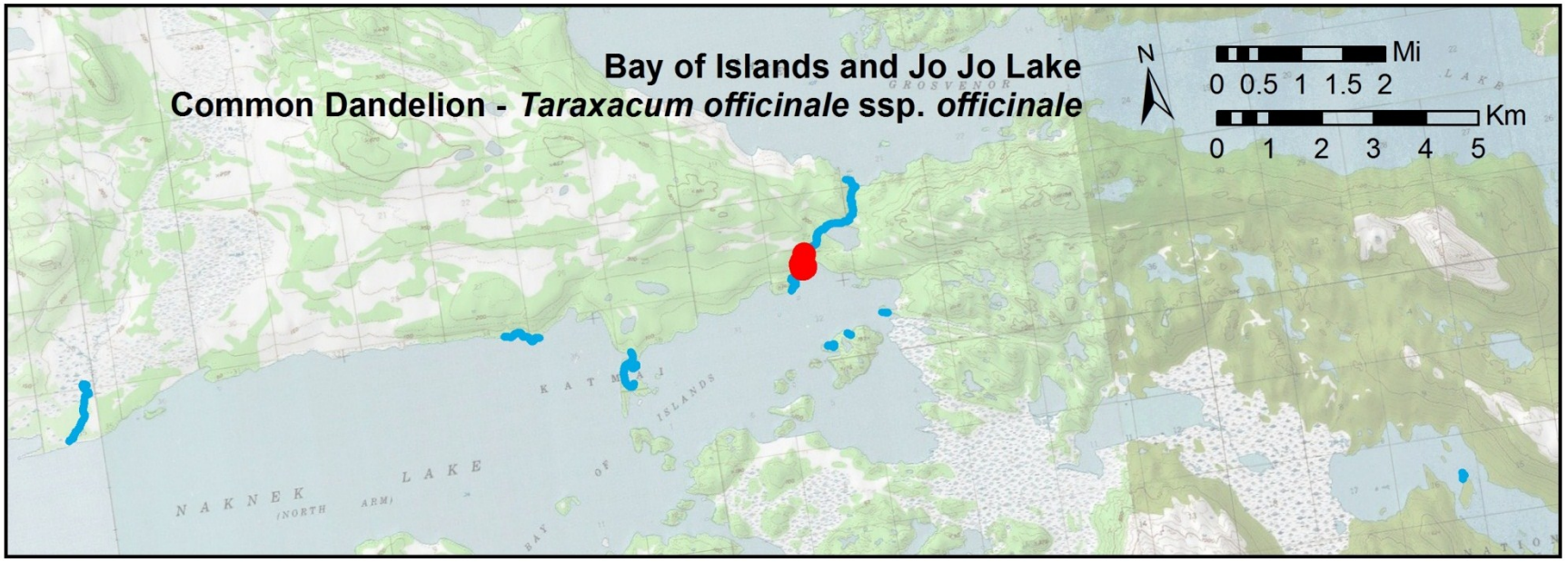

Brooks Camp and Valley of Ten Thousand Smokes Road
White Clover - *Trifolium repens*
N
Mi
0 1 2 3 4
Km
0 1 2 3 4 5 6

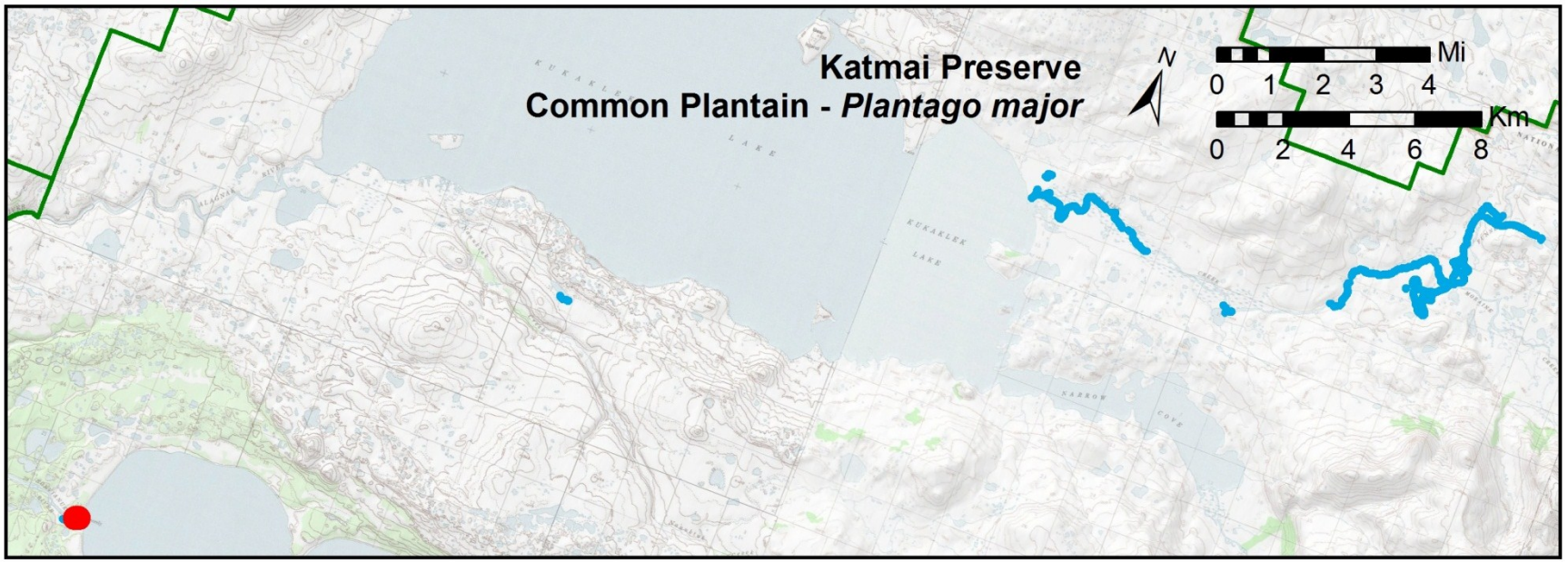

Brooks Camp and Valley of Ten Thousand Smokes Road
Bird Vetch - 'Vicia cracca
N
Mi
0 1 2 3 4
Km
0 1 2 3 4 5 6

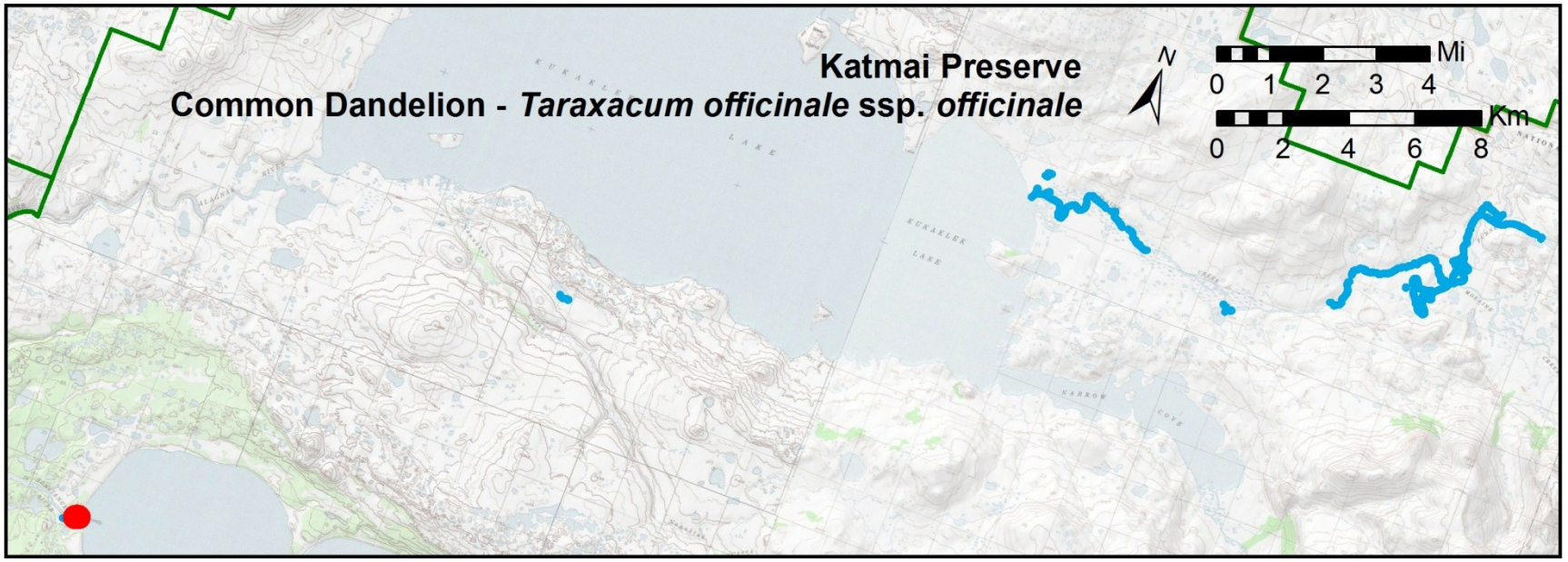

Bay of Islands and Jo Jo Lake
Shepherd's Purse - *Capsella bursa-pastoris*
N
Mi
0 0.5 1 1.5 2
Km
0 1 2 3 4 5
NAKNEK LAKE
(NORTH ARM)
BAY OF
KATMAI ISLANDS
GROSVENOR

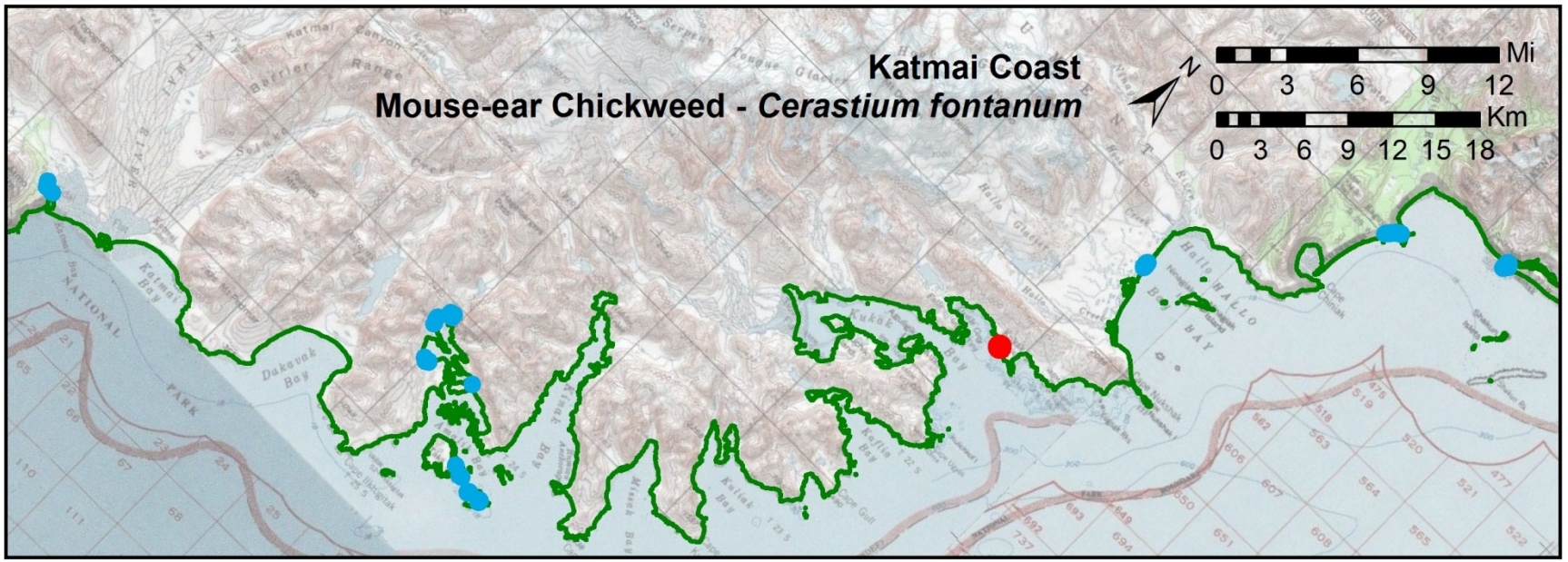

Bay of Islands and Jo Jo Lake
Pineapple Weed - *Matricaria discoidea*
N
Mi
0 0.5 1 1.5 2
Km
0 1 2 3 4 5
NAKNEK LAKE
(NORTH ARM)
BAY OF
KATMAI ISLANDS
GROSVENOR

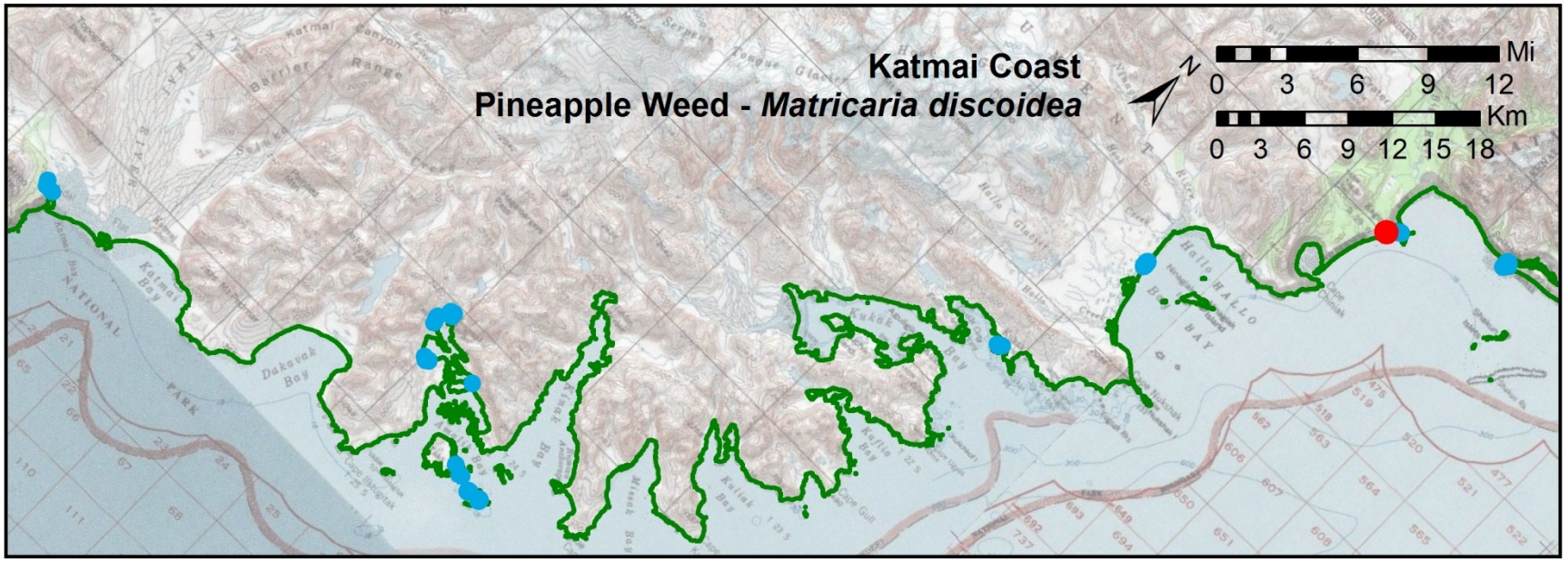

Bay of Islands and Jo Jo Lake
Annual Bluegrass - *Poa annua*
N
Mi
0 0.5 1 1.5 2
Km
0 1 2 3 4 5
NAKNEK LAKE
(NORTH ARM)
BAY OF
KATMAI ISLANDS

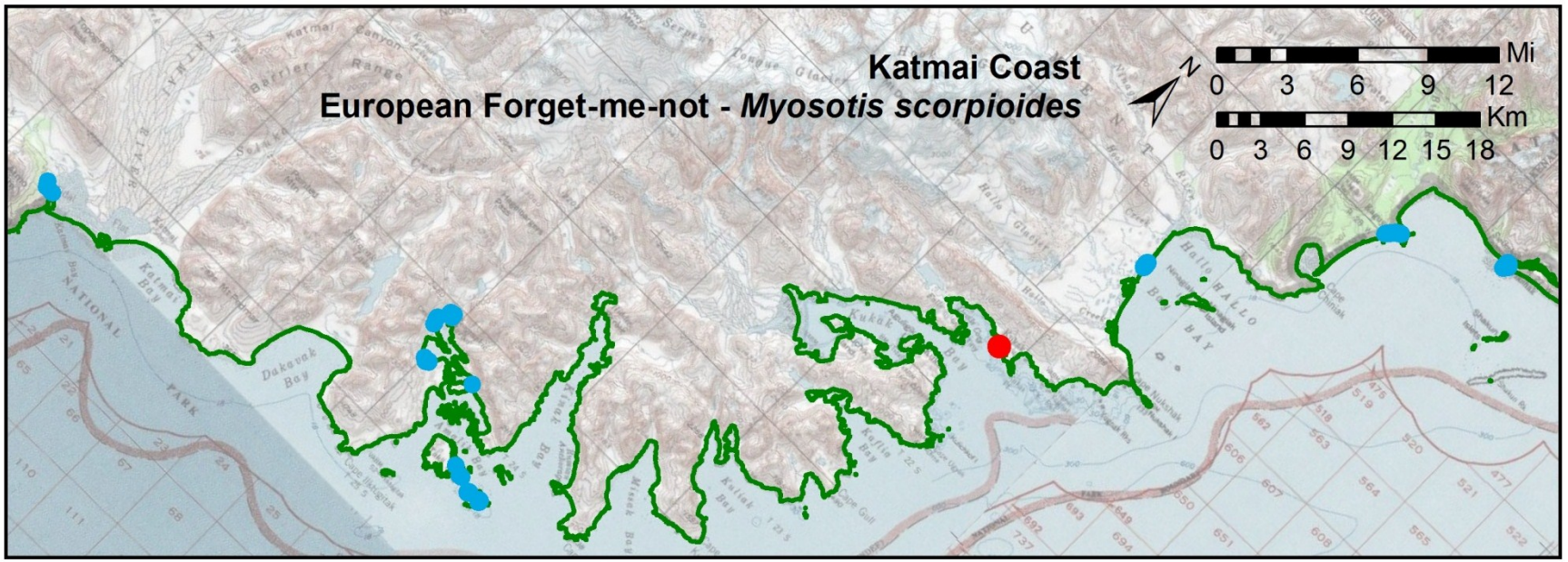

Bay of Islands and Jo Jo Lake
Common Dandelion - *Taraxacum officinale* ssp. *officinale*
N
Mi
0 0.5 1 1.5 2
Km
0 1 2 3 4 5
NAKNEK LAKE
(NORTH ARM)
BAY OF
KATMAI ISLANDS

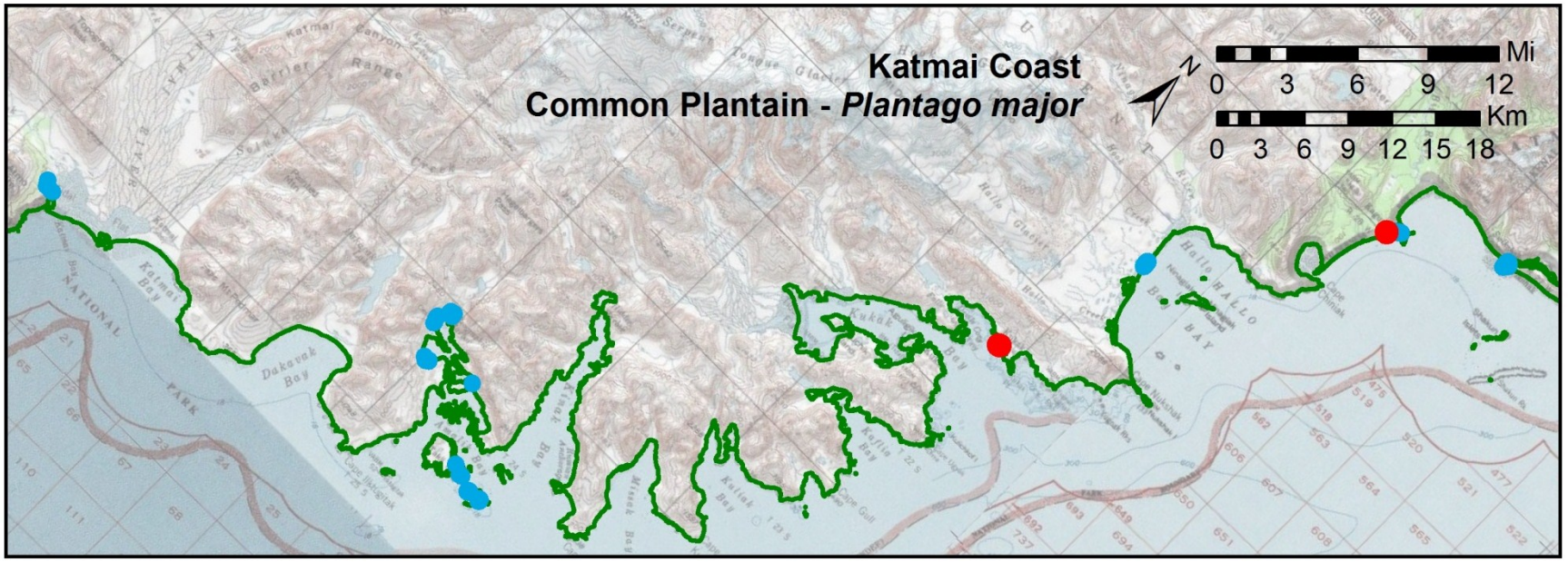

Katmai Preserve
Common Plantain - *Plantago major*
N
Mi
0 1 2 3 4
Km
0 2 4 6 8

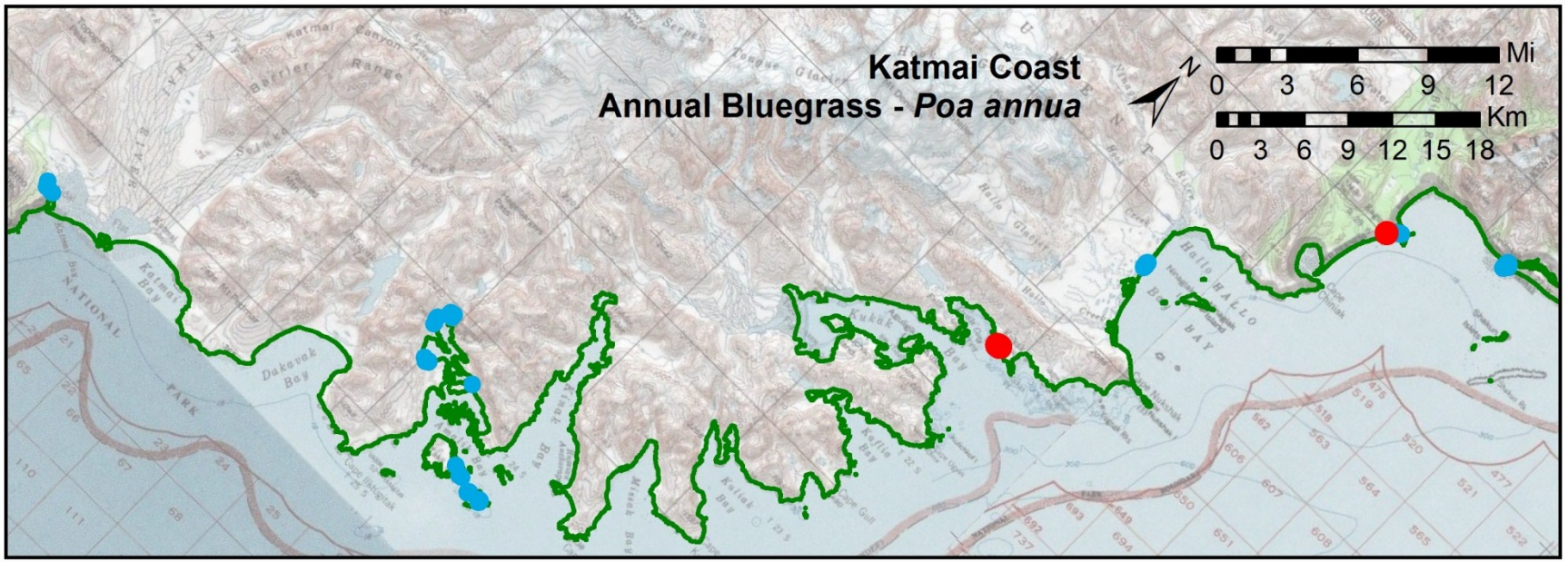

Katmai Preserve
Common Dandelion - *Taraxacum officinale* ssp. *officinale*
N
Mi
0 1 2 3 4
Km
0 2 4 6 8

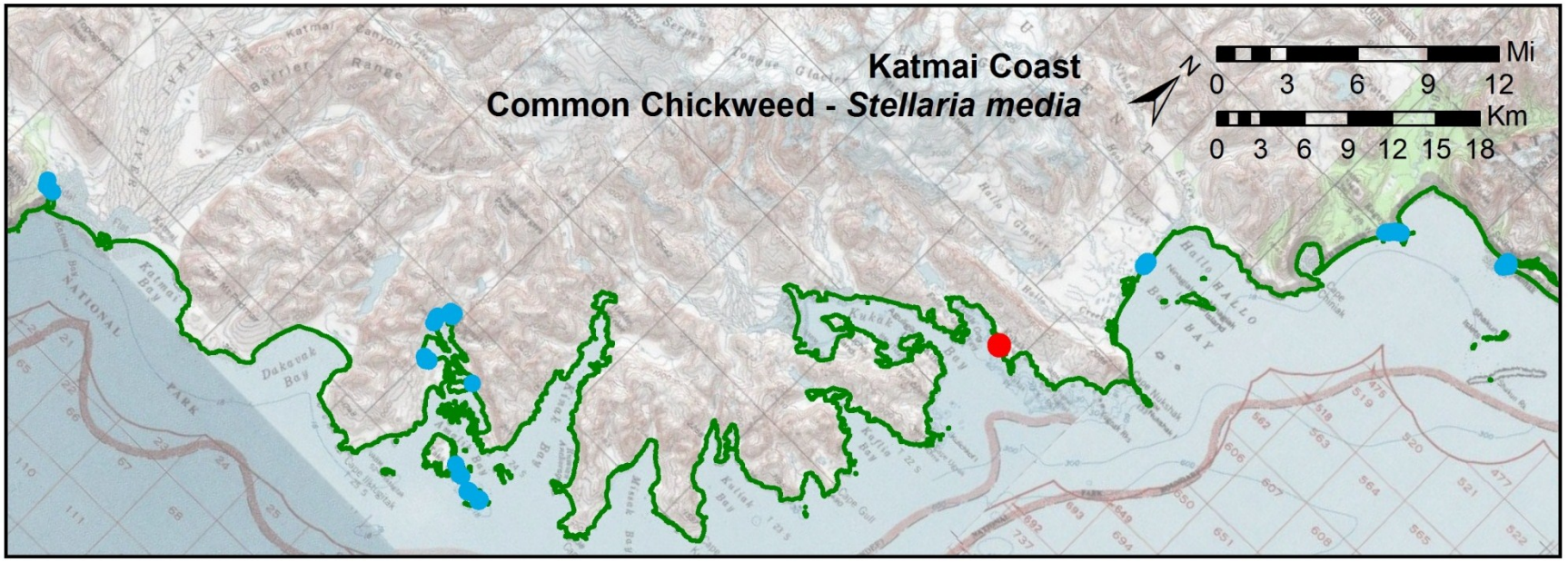

Katmai Coast
Mouse-ear Chickweed - *Cerastium fontanum*
Mi
0 3 6 9 12
Km
0 3 6 9 12 15 18

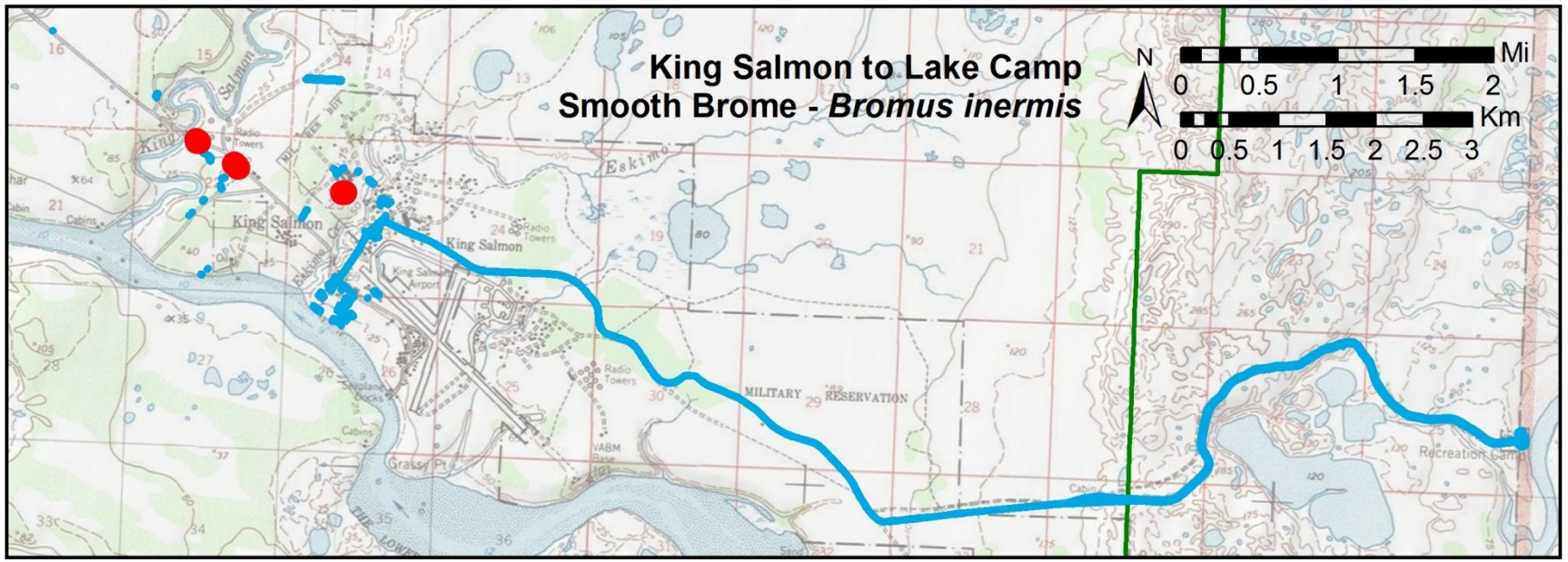

Katmai Coast
Pineapple Weed - *Matricaria discoidea*
Mi
0 3 6 9 12
Km
0 3 6 9 12 15 18

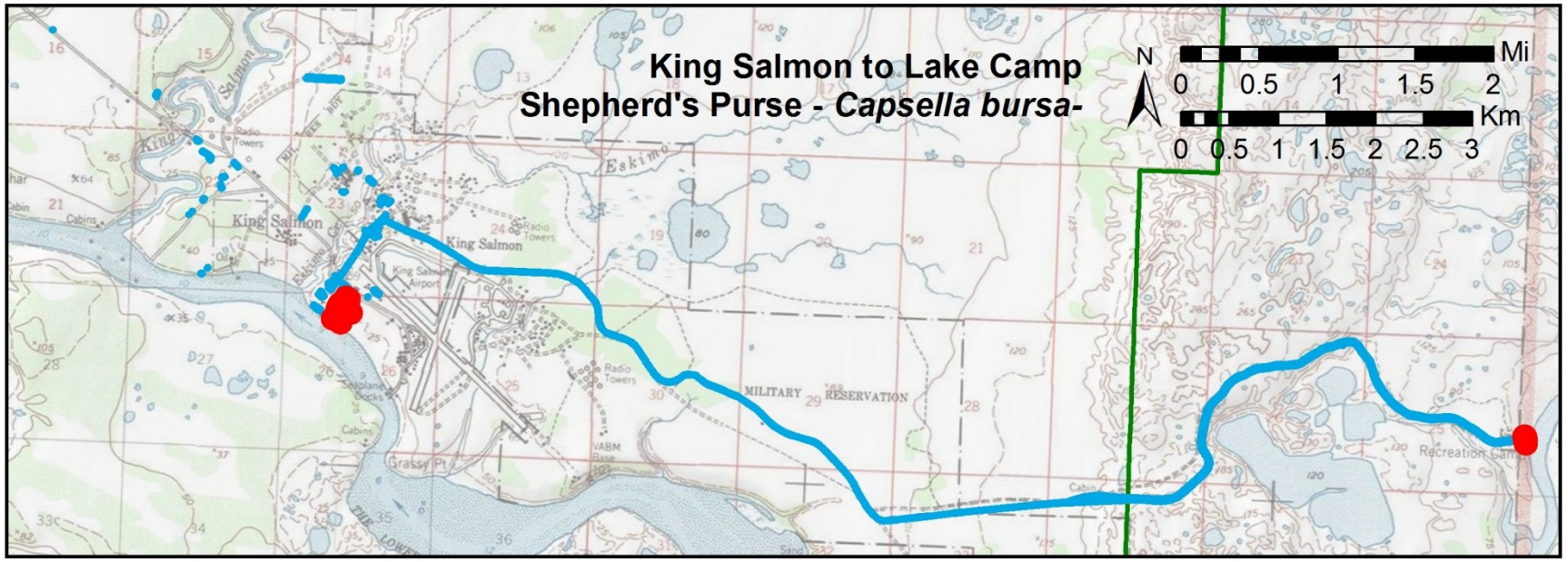

Katmai Coast
European Forget-me-not - *Myosotis scorpioides*
Mi
0 3 6 9 12
Km
0 3 6 9 12 15 18

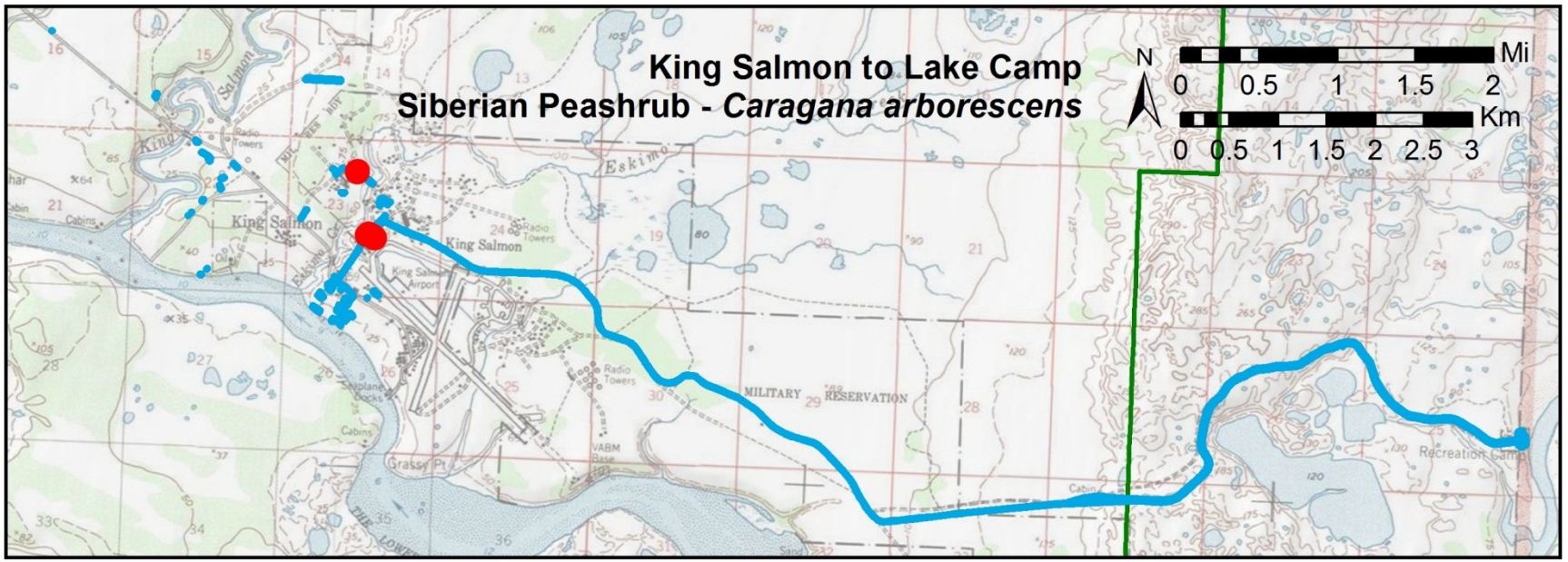

Katmai Coast
Common Plantain - *Plantago major*
Mi
0 3 6 9 12
Km
0 3 6 9 12 15 18

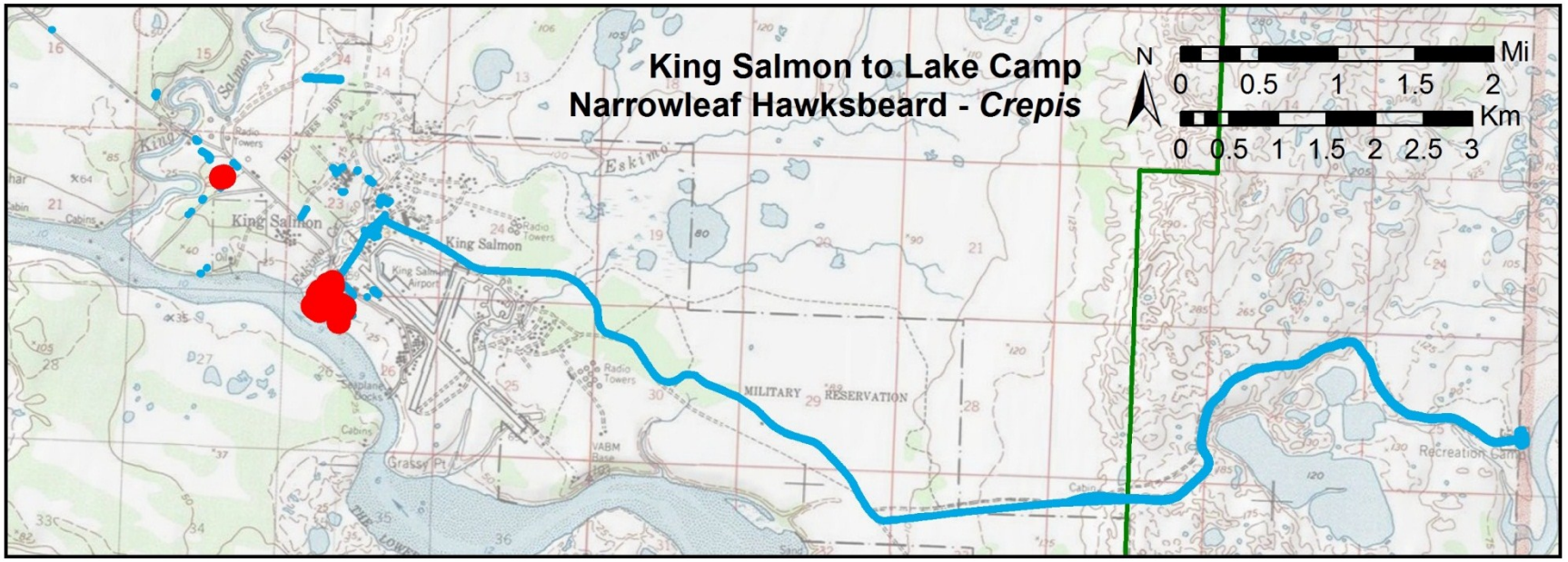

Katmai Coast
Annual Bluegrass - *Poa annua*
Mi
0 3 6 9 12
Km
0 3 6 9 12 15 18

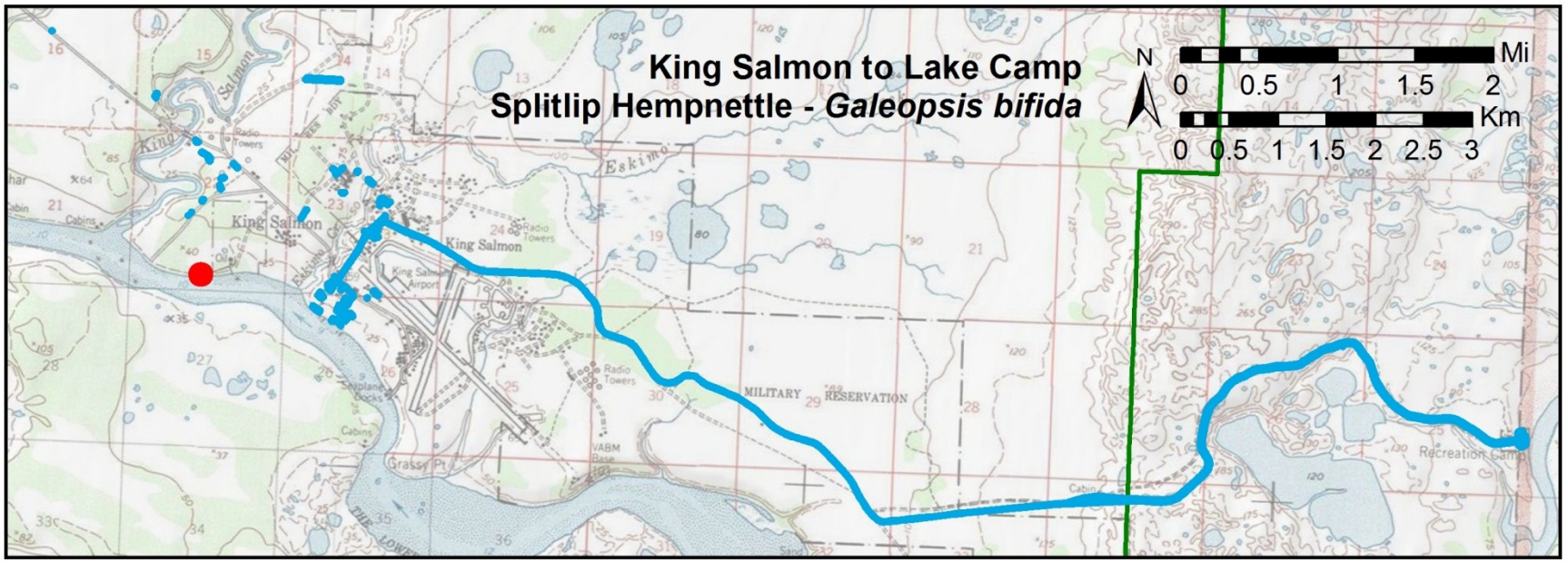

Katmai Coast
Common Chickweed - *Stellaria media*
Mi
0 3 6 9 12
Km
0 3 6 9 12 15 18

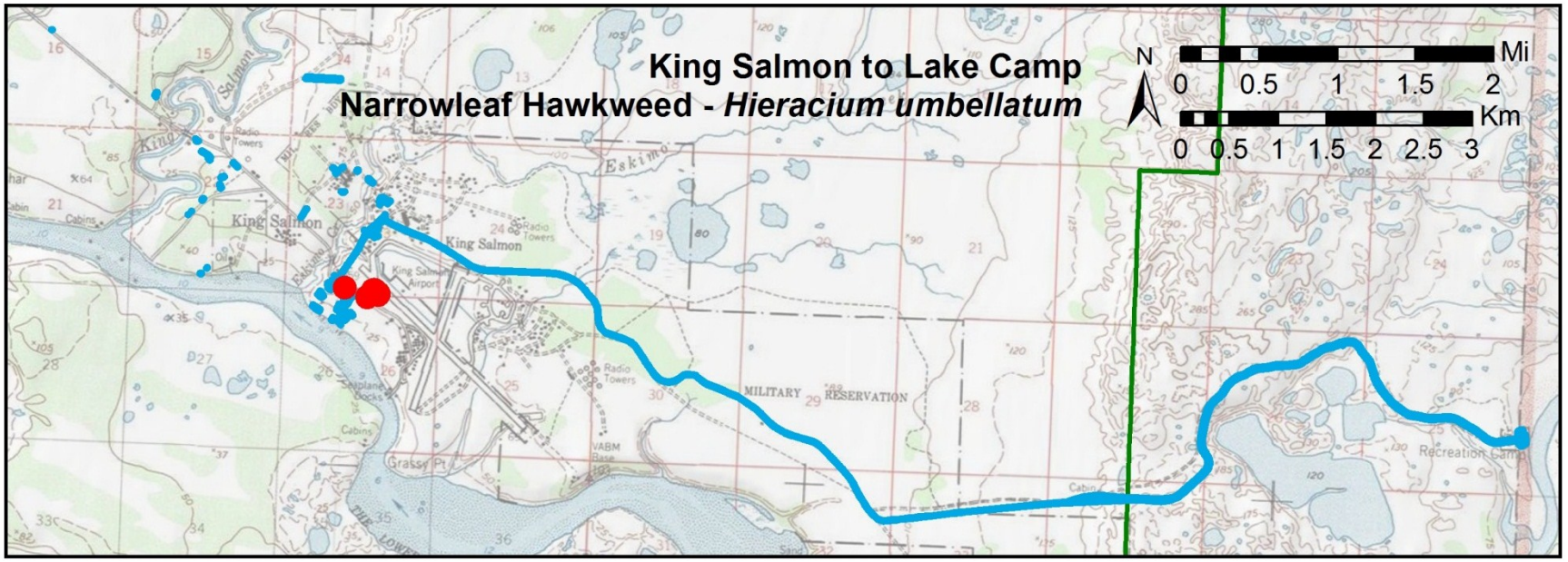

King Salmon to Lake Camp
Smooth Brome - *Bromus inermis*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp

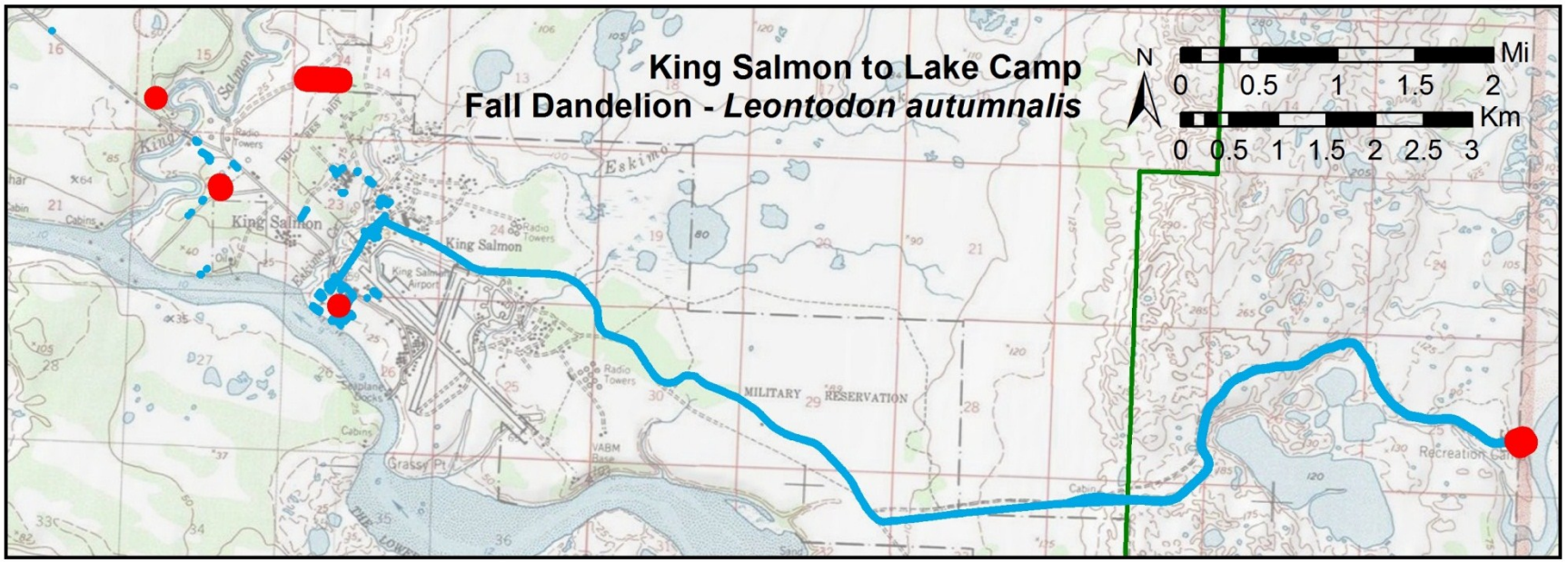

King Salmon to Lake Camp
Shepherd's Purse - *Capsella bursa-*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp

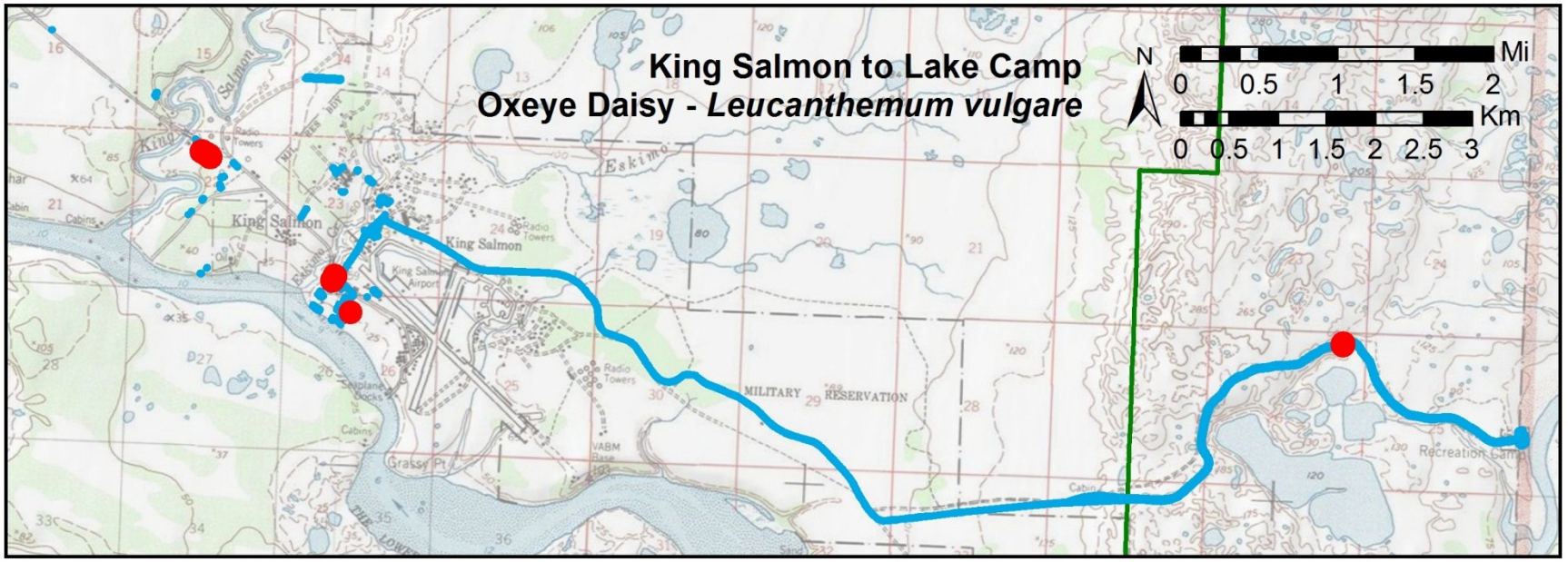

King Salmon to Lake Camp
Siberian Peashrub - *Caragana arborescens*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp

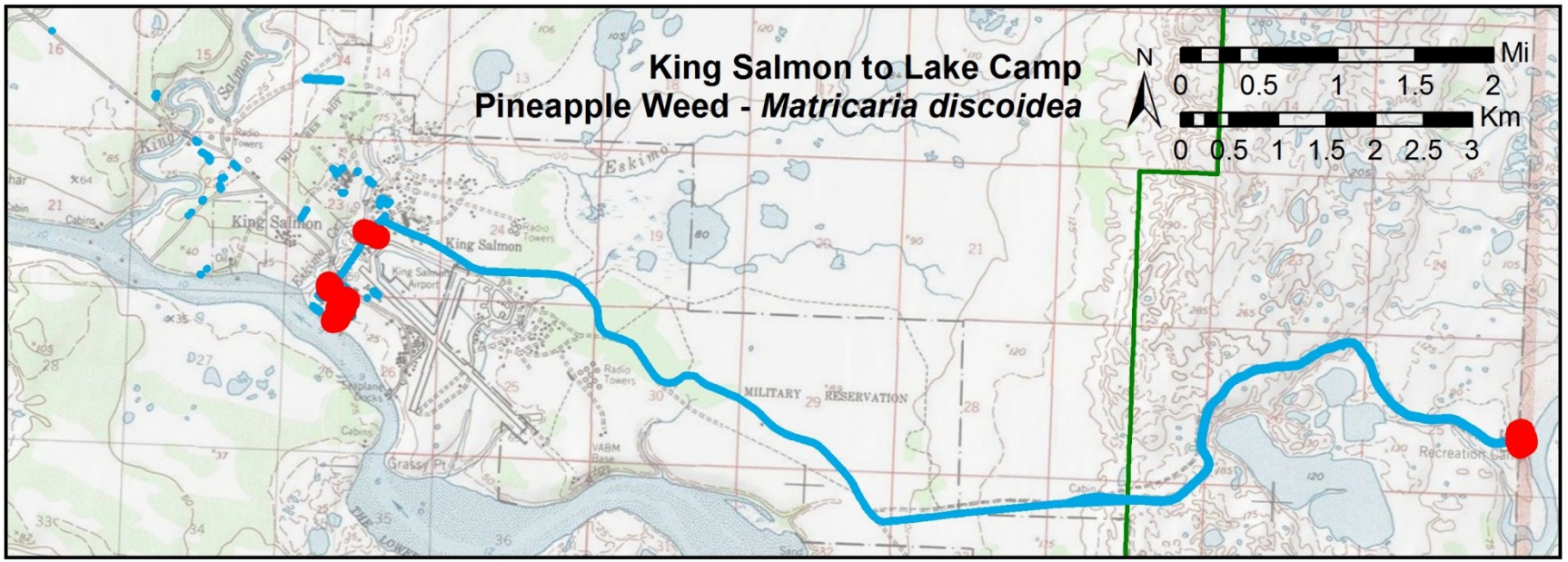

King Salmon to Lake Camp
Narrowleaf Hawksbeard - *Crepis*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp

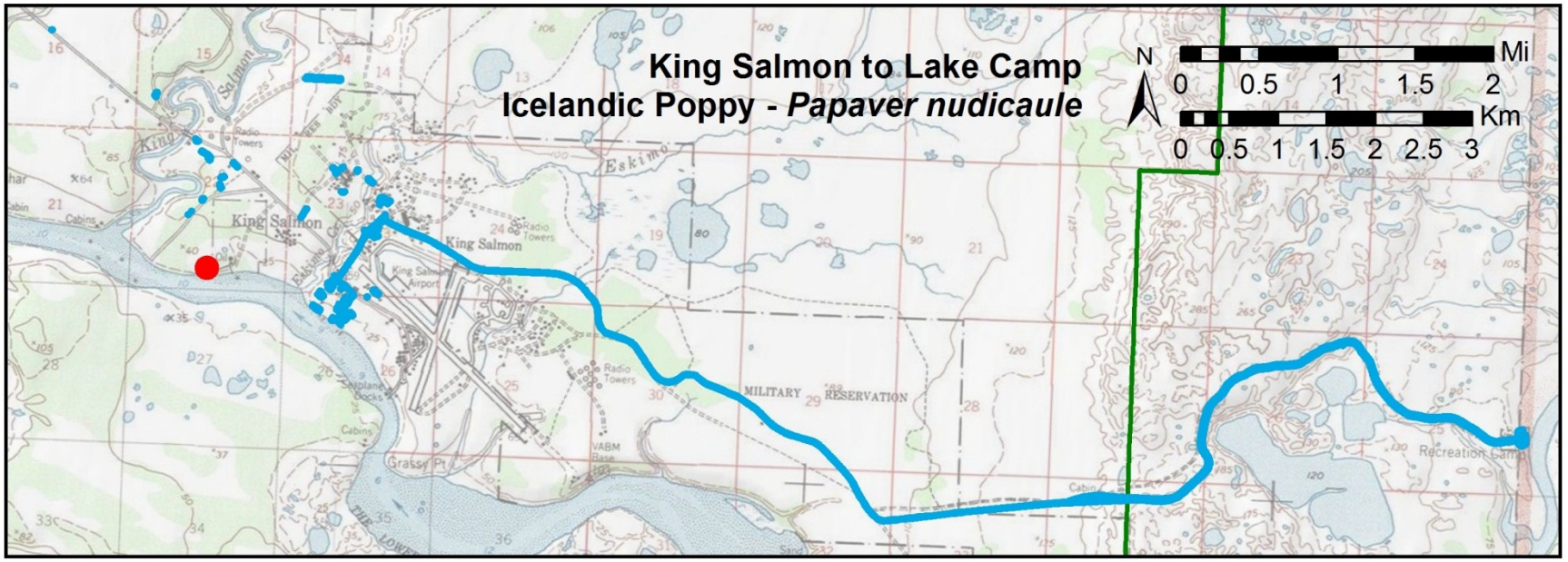

King Salmon to Lake Camp
Splitlip Hempnettle - *Galeopsis bifida*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp

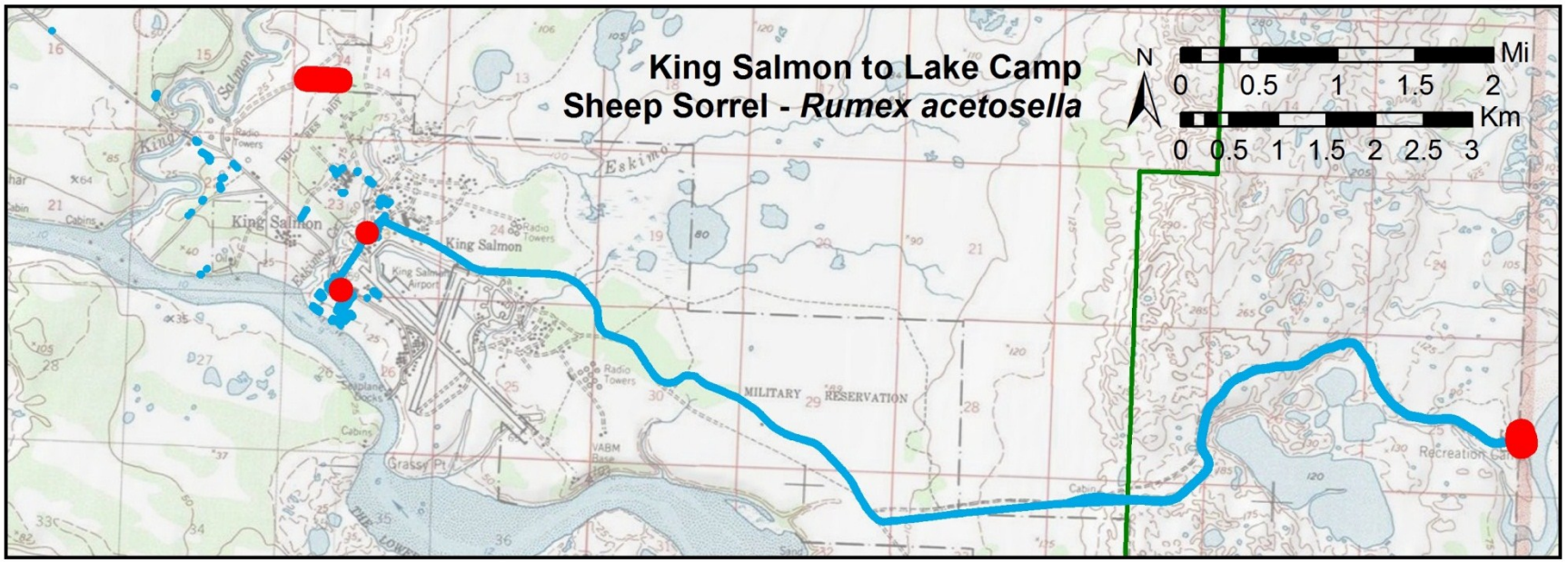

King Salmon to Lake Camp
Narrowleaf Hawkweed - *Hieracium umbellatum*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp

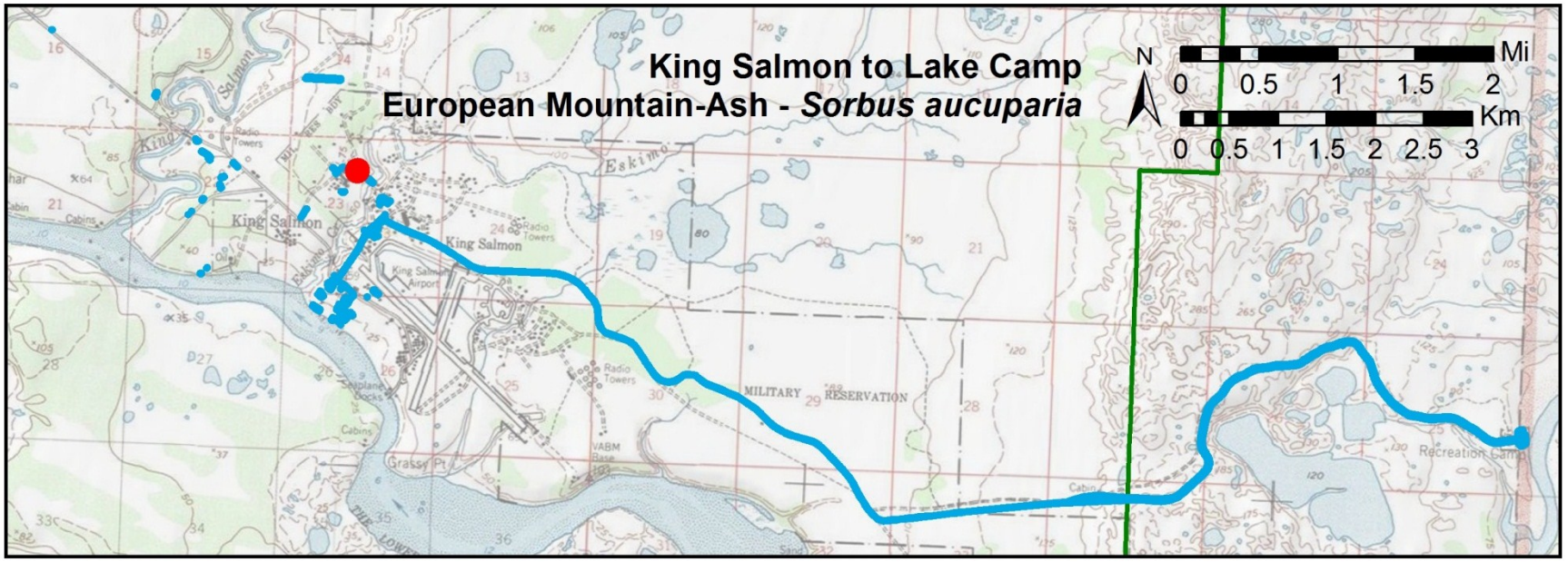

King Salmon to Lake Camp
Fall Dandelion - *Leontodon autumnalis*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
VABM
Recreation Camp

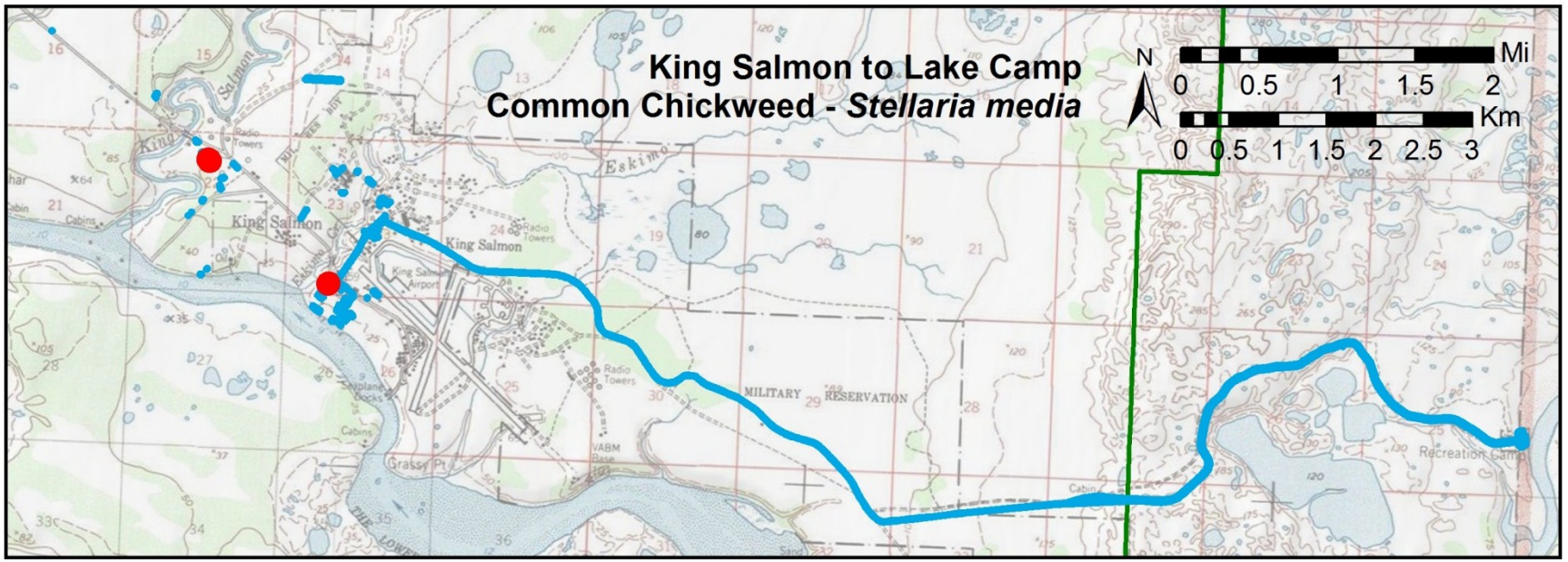

King Salmon to Lake Camp
Oxeye Daisy - *Leucanthemum vulgare*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
VABM
Recreation Camp

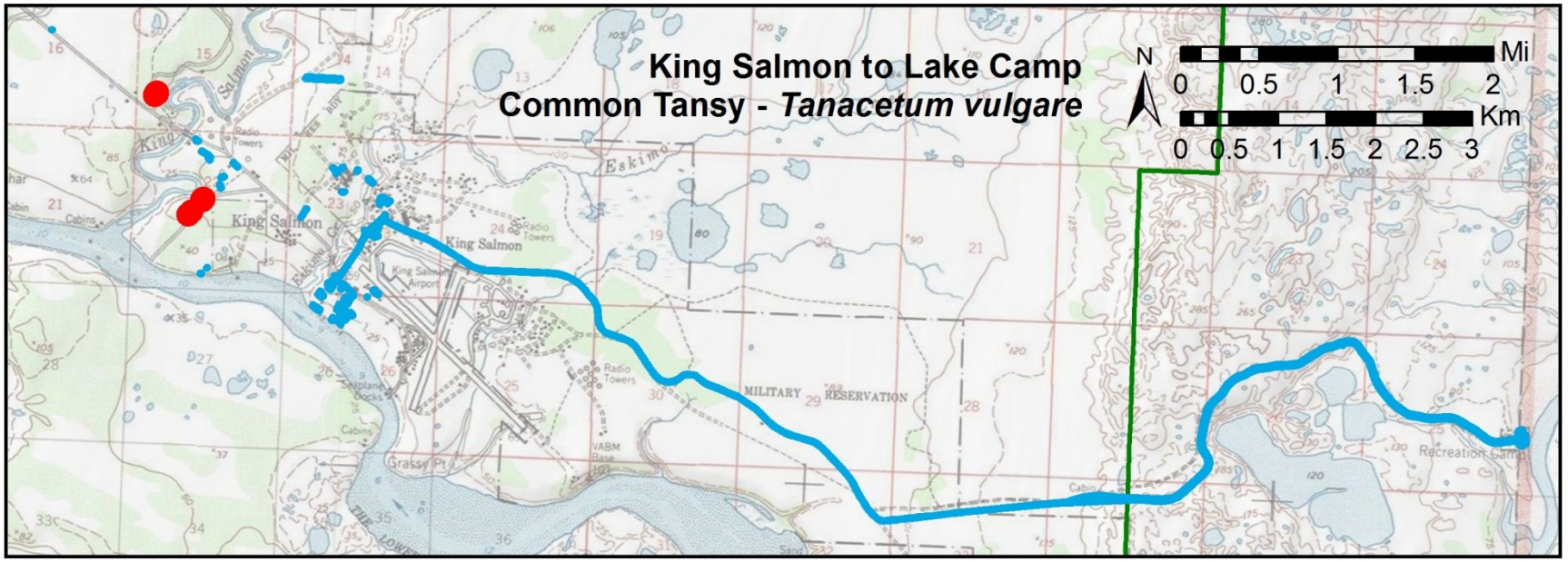

King Salmon to Lake Camp
Pineapple Weed - *Matricaria discoidea*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp

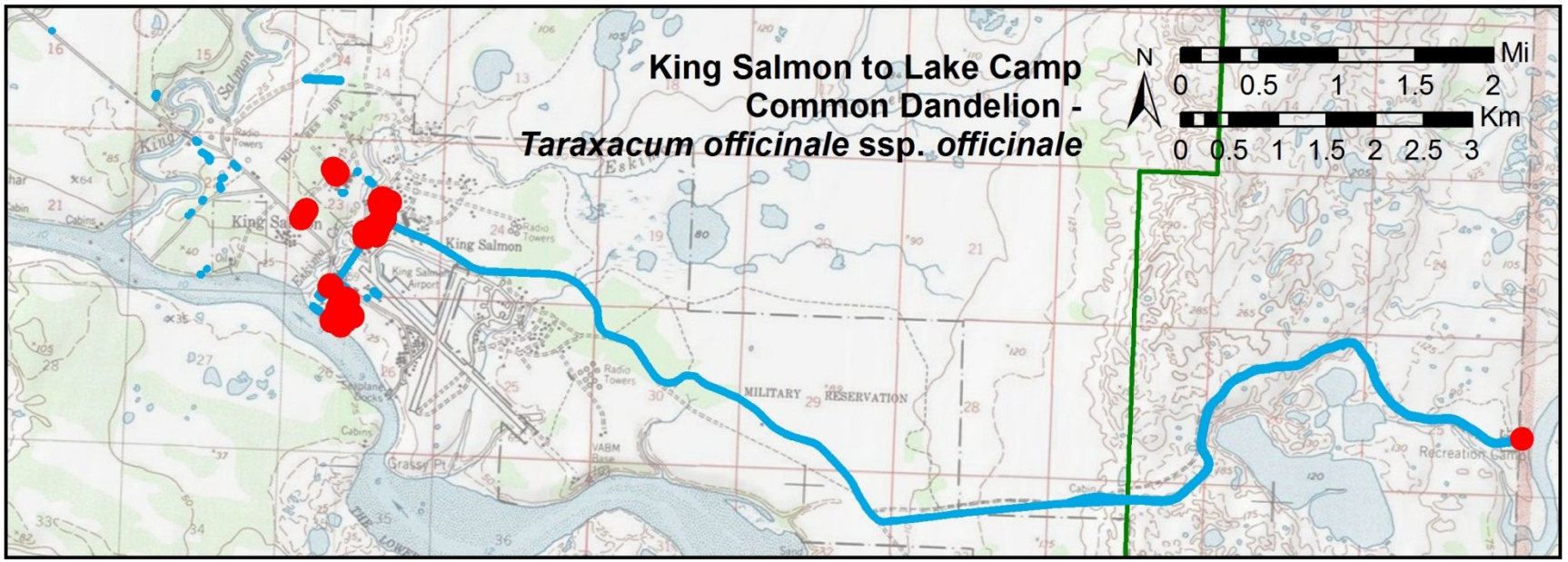

King Salmon to Lake Camp
Icelandic Poppy - *Papaver nudicaule*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp

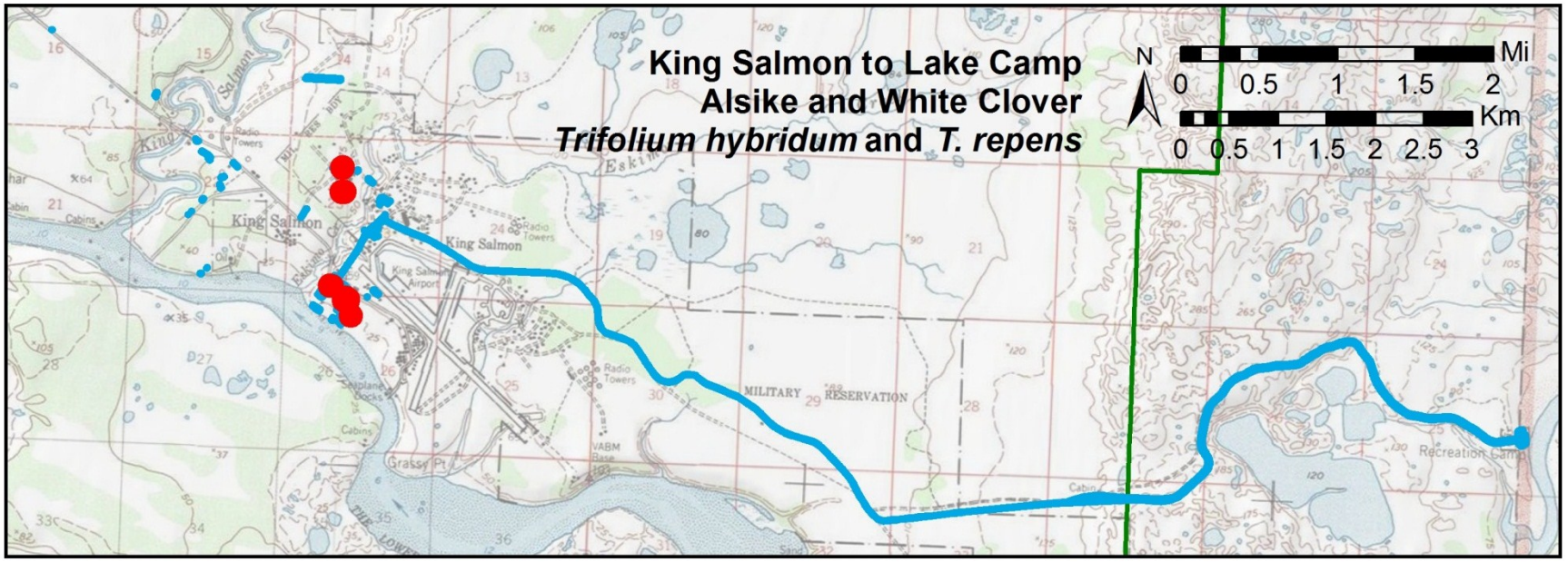

King Salmon to Lake Camp
Sheep Sorrel - *Rumex acetosella*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp

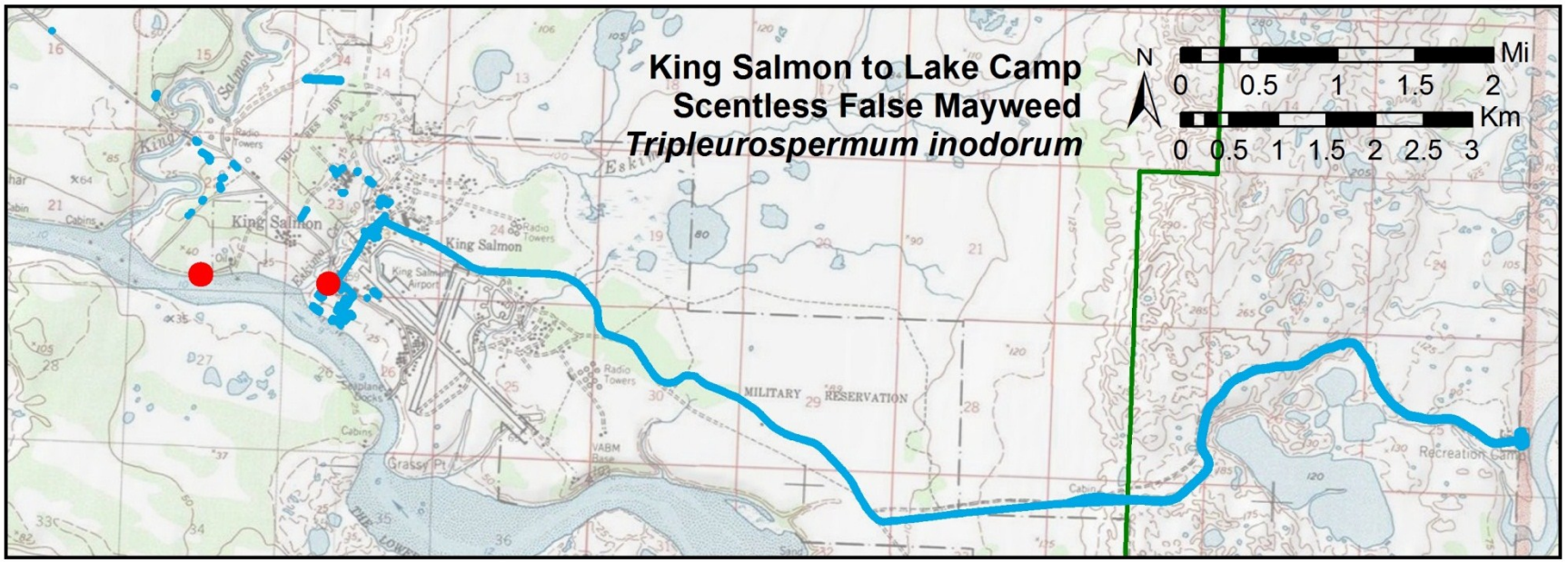

King Salmon to Lake Camp
European Mountain-Ash - *Sorbus aucuparia*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp

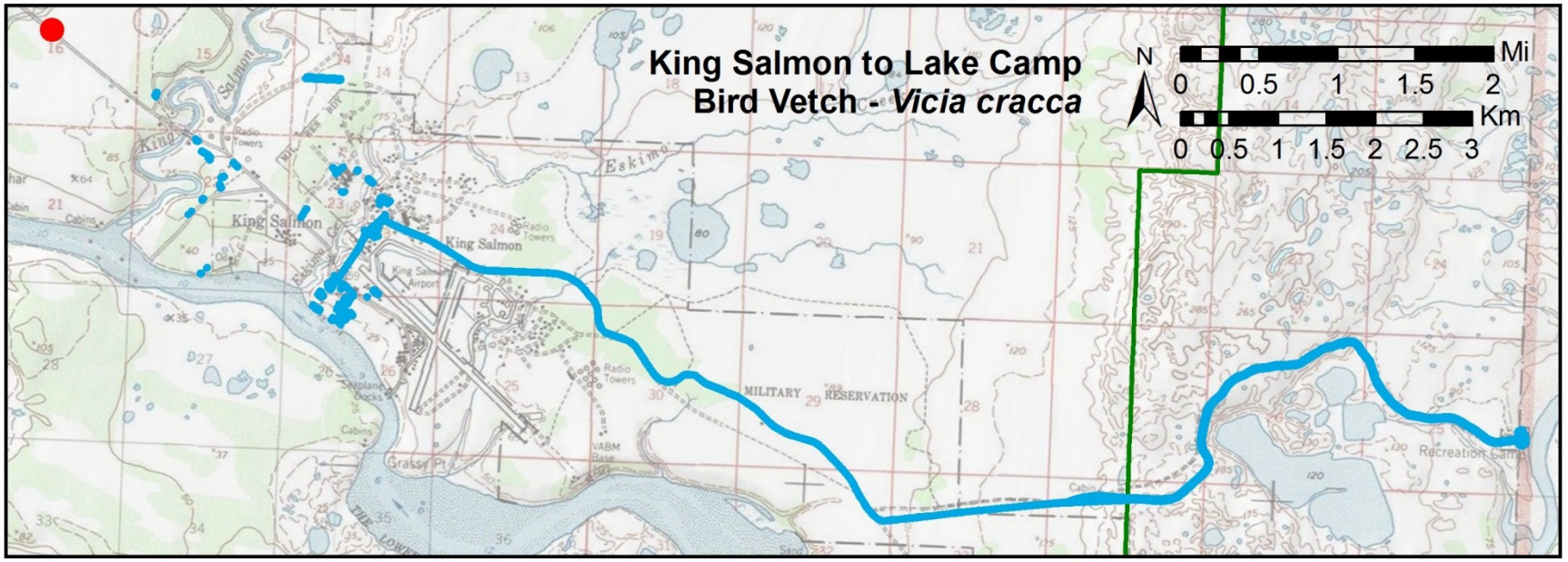

King Salmon to Lake Camp
Common Chickweed - *Stellaria media*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp


King Salmon to Lake Camp
Common Tansy - *Tanacetum vulgare*
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
Eskimo
MILITARY RESERVATION
Grassy Pt
Recreation Camp


King Salmon to Lake Camp
Common Dandelion -
Taraxacum officinale ssp. officinale
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
MILITARY RESERVATION
Grassy Pt
Recreation Camp


King Salmon to Lake Camp
Alsike and White Clover
Trifolium hybridum and T. repens
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
MILITARY RESERVATION
Grassy Pt
Recreation Camp


King Salmon to Lake Camp
Scentless False Mayweed
Tripleurospermum inodorum
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
MILITARY RESERVATION
Grassy Pt
Recreation Camp


King Salmon to Lake Camp
Bird Vetch - Vicia cracca
N
Mi
0 0.5 1 1.5 2
Km
0 0.5 1 1.5 2 2.5 3
King Salmon
MILITARY RESERVATION
Grassy Pt
Recreation Camp

Appendix B


Common Dandelion
Taraxacum officinale ssp. officinale
Bird Vetch
Vicia cracca
Narrowleaf Hawksbeard
Crepis tectorum
Sheep Sorrel
Rumex acetosella
Oxeye Daisy
Leucanthemum vulgare
CAUTION INVASIVE WEEDS CAUTION INVASIVE WEEDS
Invasive Plants
A plant is considered invasive when it becomes established outside of its native range and affects the environment, economy and human health. The invasive plants above have all been found in the Bristol Bay area. There are several thing you can do to help stop the spread of invasive species:
• Wash vehicles and gear before and after trips to prevent seeds from hitchhiking.
• Notify the Exotic Plant Management Team of invasive plants found in natural or remote areas.
• When landscaping, use plants that are native to the region or those that are not known to be invasive.
•Control any invasive plants in your own yard, garden, or neighborhood.
• Avoid disturbance of natural areas, such as clearing native vegetation or planting non-native plants.
• Volunteer your time to assist with invasive plant control projects.
For information about invasive plants, to report sightings of invasive plants, or for help identifying a plant, please contact:
The Exotic Plant Management Team at (907) 246-2145 or whitney_rapp@nps.gov
Or check us out on the web at: http://www.nps.gov/akso/NatRes/EPMT/index.html
Katmai National Park and Preserve
National Park Service
U.S. Department of the Interior

Appendix C

Invasive Plant Prevention

Katmai National Park and Preserve

National Park Service
U.S. Department of the Interior

Did You Know?

Katmai National Park and Preserve needs your cooperation in keeping its unique native ecosystems pristine. Help us to prevent invasive species.

Invasive plants are easily transported by:

- Boots
- Tents
- Velcro®
- Backpacks
- Clothes
- Equipment

- Remove plant material, seeds, and soil from gear.
- Use the boot brush below.

Thank You.